University of Texas Bulletin

No. 1860: October 25, 1918

The Geology and Mineral Resources of Medina County

BY
R. A. Liddle

Bureau of Economic Geology and Technology
Division of Economic Geology
J. A. Udden, Director of the Bureau and Head of the Division

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The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

Sam Houston

Cultivated mind is the guardian genius of democracy. . . . . It is the only dictator that freemen acknowledge and the only security that freemen desire.

Mirabeau B. Lamar

THE GEOLOGY AND MINERAL RESOURCES OF MEDINA COUNTY

BY

R. A. LIDDLE

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THE GEOLOGY AND MINERAL RESOURCES OF MEDINA COUNTY[1]

By R. A. LIDDLE

GEOGRAPHY

GEOGRAPHIC LOCATION

Medina County is located in south-central Texas, approximately between latitude 98° 45′ and 99° 25′ west, and longitude 29° 5′ and 29°′ 35′ north. On the north it is bounded by Bandera County, on the west by Uvalde County, on the south by Frio County, and on the east by Atascosa and Bexar counties.

The Southern Pacific Railroad passes east and west across the center of the county; through Hondo, the county-seat, in the central part, and through D'Hanis in the western part. At Devine, the International and Great Northern Railroad passes through the southeastern part of the county.

There are included in Medina County approximately 2380 square miles of territory, which supports a population of about 1700, according to the 1920 census.

PHYSIOGRAPHY

PHYSIOGRAPHIC LOCATION

Two of the major physiographic provinces are represented in Medina County. The Edwards Plateau, the southern extension of the Great Plains, reaches from the north to the Balcones Escarpment, which extends east and west across the northern part of the county. South of this

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[1]Manuscript submitted September, 1920. Published March, 1921 but numbered in the 1918 series in order to complete the series for that year in conformity with postal requirements.

escarpment, the low plains with minor relief belong to the Rio Grande Embayment. The sediments lying in a synclinal trough between the Balcones Escarpment on the north and the Mexican sierras on the south, slope gently southeastward toward the Gulf of Mexico.

The Balcones Escarpment, which marks the boundary between the Edwards Plateau on the north and the Gulf Coastal Plain on the south, enters Medina County on the east, eight miles south of the Bandera County line, and curving northward in its course, leaves the county on the west,

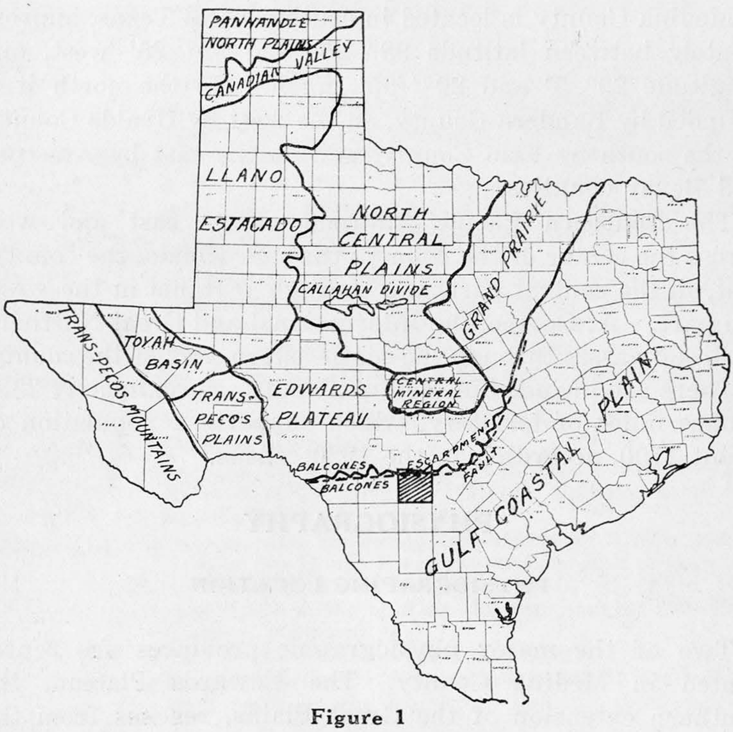

Figure 1
Sketch map showing the location of Medina County with respect to the major physiographic provinces of Texas

seven miles south of the Bandera-Medina county line. In the distance of 36 miles across the county, the Balcones Escarpment extends three miles north of an east and west line connecting its points of entrance into and exit from the county.

The 'maximum swing to the north is in the central part of the county. Only about one-twentieth of the county, lying north of the Balcones fault, belongs to the Edwards Plateau sub-province of the Great Plains. The remaining area, which includes practically the entire county, lies south of the escarpment, in the Gulf Coastal Plain.

The two main physiographic provinces may be differentiated by the range of relatively smooth, high, conical Glenrose hills, which stands out as the prominent relief of northern Medina County. The Edwards hills to the south are of considerably less elevation and their rugged appearance and flint-covered surfaces easily distinguish them.

The geographic and physiographic location of Medina County with respect to the State of Texas and the major physiographic provinces is indicated on the accompanying sketch.

TOPOGRAPHY AND DRAINAGE

Geologic structure in Medina County to a great extent determines both the major and minor physiographic provinces. The direction of the drainage is also in general dependent upon geologic structure.

North of the Balcones Escarpment, the topography of the county, though varied, is of a more gentle type than that immediately south of the escarpment. The Glenrose limestone, which in weathering affords a varied relief, through its physical properties, gives rise to more gentle slopes and less rugged hills, north of the Balcones Escarpment. The cliffs which fringe the Edwards hills to the south of the escarpment are almost entirely wanting in the Glenrose area. The Glenrose hills are higher than those of the Edwards area, but much gentler in slope, smoother in appearance, and more conical in form. On all sides of the hills the Glenrose limestone weathers with equal rapidity, giving a uniform slope. The local highly indurated phases of the Edwards, with much flint, produce very rugged slopes.

North of the Balcones Escarpment the strata composing the Glenrose hills dip very gently toward the south. In the proximity of the Balcones fault this dip rapidly increases from 5 feet to approximately 100 feet to the mile. As a rule the tops of the cuestas have a dip slope corresponding to the dip of the strata of the region in which they are located.

South of the Balcones Escarpment the alternating more or less indurated strata of the different formations give a varied relief. With local exceptions the formations dip to the south, and in general the slope of the country is in a southerly direction. However, as the dip of the formations is greater than the slope of the country, successively younger formations are encountered from north to south in the county. This is, however, slightly modified locally by various features. Since the dip of the strata is to the south and the formations are in general composed of alternately harder and softer layers, the resultant topography is of the cuesta type, with northward-facing escarpments. These cuestas pass under higher strata to the south with no break in themselves, the southern limit of their surficial exposure being marked by the northward-facing escarpment of the next younger strata.

As the alternating formations are generally composed of more or less resistant layers, those formations which are composed of harder strata stand out as the prominent relief while the softer materials of the less resistant formations produce the valleys and the lowlands. The formations containing harder material have more abrupt northward-facing escarpments, while the softer formations sometimes have no escarpments of their own, unless capped by harder formations. A familiar type of this class of topography is exemplified in two northward-facing limestone escarpments, separated by a valley which is underlain by an argillaceous formation. The Del Rio clay, surficially outcropping between the older Georgetown-Edwards formation escarpment and the younger Buda formation scarp, is a typical example.

Since the dip of the county is in general to the south and southeast, the outcrop-strikes of the formations are in general east and west or northeast and southwest. A notable change in these strikes occurs in western Medina County. There is also a marked contrast between the strike of the Cretaceous and the Eocene formations. From the east boundary of Medina County the Cretaceous and Eocene formations outcrop in a general direction of slightly southwest and northeast. In the western one-third of the county the strike of the Eocene formations rapidly turns to the south while that of the upper Cretaceous turns northward. The general Rio Grande Embayment stratigraphy seems to be accountable for the change toward the south in the strike of the Eocene formations, but as yet there is no adequate explanation offered for the northward turn in the line of outcrop of the Upper Cretaceous strata in western Medina County.

Over the surface areas of some of the less resistant formations there has been Cenozoic deposition of more recent material. As a rule these localities are confined to the less resistant formations.

Edwards flint in the form of the Pleistocene-Uvalde formation frequently covers the formations south of the Balcones Escarpment and, regardless of the nature of the underlying formation, protects it from erosion. The Wilcox and Carrizo formations and the softer parts of the Escondido formation are thus often protected from erosion.

The surface drainage of the county is in general to the south and southeast, coincident with the general dip of the strata and the slope of the country. Local structural movements modify the general drainage conditions. A notable example is Cypress Creek, in the northeastern part of the county. This creek rises in the Glenrose limestone north of the Balcones Escarpment and flows southeast till it encounters the Balcones fault and the very resistant Edwards limestone to the south. The course of the creek is then changed to due east and it flows in the Balcones fault till it empties into the Medina River.

In addition to the Medina River which drains the northeastern quarter of the county, the Hondo River and its main tributaries, West, Middle, and East Verde creeks, and Seco Creek, are the main drainage features of Medina County. Into these streams empty smaller tributaries which drain more local areas.

The Medina River is the only stream which is permanently flowing throughout its entire course in Medina County. It is fed chiefly from springs in the Glenrose and Edwards limestones in the northern part of Medina County and in the area to the north. Except for a very short time after rains, all the remaining creeks in the southern part of the county are dry. Of these main intermittent streams which are generally dry in the southern part of the county, the Seco Creek, Hondo River, and Verde Creek, are practically permanently flowing in the northern part of the county. The water supplying these streams comes from fissure springs in the Glenrose and Edwards limestones, and after flowing along the stream courses for some distance, disappears under the gravel in the creek and river beds.

CLIMATE AND RAINFALL

The location of Medina County between the semi-arid southwest and the more humid Gulf Coastal Plain affords a moderate climate with no excessive temperature. The hills in the northern part of the county break the force of the "northers" of the winter season, making the climate quite equable. No official records of temperature and rainfall are taken in Medina County and the data here included are obtained from personal observations and from the observations in adjacent counties.

For Bexar County, Sellards[2] records an average mean temperature of 69° F. with a range of from 40° F. in the winter to 106° F. in the summer. There is little difference between these temperature observations for Bexar County

[2]Sellards, E. H., Geology and Mineral Resources of Bexar County. Univ. Texas Bull. 1869, p. 13.

and the temperatures which exist in Medina County. With the annual mean temperature of 69° F. there is a rainfall of about 28.4 inches. These conditions exist only in normal years. Much less rainfall occurs in years of drouth.

For the fall and winter months, from October through March, the rainfall is generally a little less than two inches a month and during the remainder of a normal year it will average about 3 inches.

THE BALCONES ESCARPMENT

The line of demarcation between the Edwards Plateau on the north and the Gulf Coastal Plain on the south is the Balcones Escarpment. This escarpment is a prominent topographic and physiographic feature, as well as an important geological consideration. The position of the Balcones Escarpment, which is determined by the main line of faulting of the Balcones fault zone, is in a general east and west direction across the northern end of Medina County. Topographically the escarpment is marked by an abrupt increase in the height of the hills to the north. Physiographically it is denoted by the more varied, though gentler, types of relief. The sharp-pointed hills with practically no vertical scarps, and gentle, grassy, talus-covered slopes, strongly contrast with the rugged, broken, irregular, lower hills to the south of the main fault. Geologically the Glenrose hills to the north, with distinctive lithologic and paleontologic features, are sharply demarcated from the hard, massive, flint-bearing, unfossiliferous Edwards limestone hills to the south of the main fault.

The main Balcones Fault which marks the position of the Balcones Escarpment, enters Medina County on the east, eight miles south of the Bandera line, and turns slightly to the north as far as the middle of the county. West from this point it swings south and leaves the western boundary of the county some seven miles south of the Medina-Bandera county line. Along its entire course the main Balcones fault is marked by the gently sloping Glenrose hills on the north and the slightly lower, massive, rugged, flint-bearing Edwards hills to the south.

Although smaller faults are present in the Glenrose hills to the north of the Balcones Escarpment, the northernmost main fault of the Balcones zone is located as described. To the south there is also extensive faulting in the more recent formations. The detail of the entire Balcones fault zone and associated structural features is discussed more fully under Structural Geology.

SOIL AND VEGETATION

With the exception of the river flood-plains and terraces, the different classes of soil and the associated vegetation are dependent upon geological formations. For each

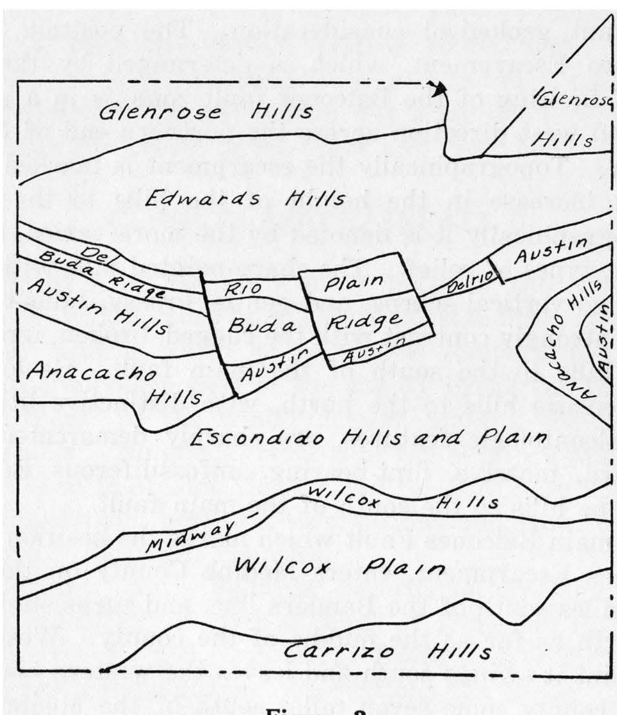

Figure 2

Sketch map showing the main physiographic provinces of Medina County.

formation there is a typical residual soil which supports a characteristic vegetation. The calcareous and argillaceous formations of the northern part of the county weather differently and support a different vegetation from that which exists on the arenaceous formations of the southern part of the county. Under a discussion of the minor physiographic divisions which are practically determined by the different geological formations, a more detailed discussion of the resultant soil and the associated plant life will be given.

The flood plains of the streams have a heterogeneous composition of soils and rock fragments gathered from the different geologic formations exposed in the drainage area of the streams above any particular locality. These terrace deposits afford the best agricultural land in the county.

MINOR PHYSIOGRAPHIC DIVISIONS

Several divisions of the two major physiographic provinces represented in Medina County can be made. In general these physiographic divisions are coincident with the respective geological formations. However, two adjoining formations which are practically identical in physical properties are generally represented by a single physiographic division. The Eagleford and the Austin formations are an example of this combination. Though in places the Eagleford shales and marls form a small valley to the north of the Austin hills, in general the two formations afford but one physiographic division. Since these divisions are confined practically to the limits of one or more geological formations, their general extent is the same as the extent or the outcrop of the formations. Over practically the entire county, the direction of outcrop of the formations is mainly northeast and southwest. The names of the surficial geologic formations which afford types of physiography have been assigned to the corresponding physiographic divisions.

The Glenrose Hills:

The area to the north of the Balcones Escarpment, which is the southern extension of the Great Plains, is referred to as the Glenrose hills. The surface formation over the entire area, with the exception of the very restricted igneous intrusions, is the Glenrose limestone of the lower Comanchean-Cretaceous. This formation consists of thin-bedded, moderately soft, alternating calcareous and argillaceous limestones, which, on weathering, afford a gentle slope. The greater resistance of the more indurated ledges and the undermining of these by the weathering of the marly ledges produces a banded appearance on the hillsides. The slopes are smooth and in general support considerable vegetation. The hills are generally quite high but their inclines are gentle. There is an entire absence of the rough, broken appearance of the Edwards hills to the south. The moderately soft, thin-bedded ledges afford no high vertical cliffs and even the headwater erosion of the streams produces practically no canyons. The entire topography is varied but gentle. On the lowlands and especially along the streams there is a quantity of grass and a considerable number of live oak trees. On the hillsides the chief vegetation is some grass, mountain cedar, and some small scrub oaks.

The average height of the hills is about 200 to 300 feet above the stream valleys.

The Edwards Hills:

South of the Balcones Escarpment and extending east and west across the county, averaging about seven miles in width, are the flint-covered Edwards limestone hills. The entire surficial area of the Georgetown-Edwards limestone is included in this topographic division. This area is easily distinguished from the Glenrose hills by the exceedingly rough and broken topography and the great amount of flint in and covering the surface formation. All of the hills are in general bounded on one side at least by a nearly vertical scarp from 10 to 30 feet high. Also there are some pockets or cavities filled with limonite which in weathering often stains the flint or the entire surface soil to a deep red. The hillsides, unlike those of the Glenrose area, are rough, steep, and generally covered with large boulders. There is a less amount of mountain cedar and an increase in the number of scrub oaks and other shrubby trees. With the exception of the grass in the narrow valleys, there is little vegetation in the area occupied by the Edwards hills.

The Del Rio Plain:

Along the southern boundary of the Edwards flint hills, there is generally a narrow valley. With the exception of the central part of the Del Rio area, which has an average width of one and one-half miles, due to block faulting, this valley is less than one-half mile in width. Its location is due to the position of the soft material of the Del Rio formation. This formation is composed chiefly of soft yellow clay with a few thinly bedded, more or less indurated ledges. On recently weathered surfaces the Del Rio formation is yellow or reddish-brown but when mixed with humus is generally almost black. The surface outcrop is at once recognized by the great amount of flat nodular limonite particles, as well as by the abundance of *Exogyra arietina,* a small coiled oyster, found at recent surface exposures. The Del Rio area, lying between the Edwards flint hills on the north and the Buda limestone hills or ridge on the south, furnishes excellent agricultural lands. The chief native vegetation of the Del Rio plain is grass and in addition, considerable mesquite, with some live oak.

The Buda Ridge:

Demarking the Del Rio valley on the south is a narrow ridge of hard white limestone. Its areal extent is practically equivalent to and conformable with the Del Rio plain, since the same block faulting has determined the areal width of each formation. This area is more correctly referred to as a ridge than as a range of hills, for the Buda area stands only some 40 to 50 feet above the Del Rio plain. However, this upland is distinctly marked from the Del Rio plain both by physiographic and geologic features. The surface is rough and not unlike the non-flint-bearing low hills of the Edwards limestone. The soil is thin, highly calcareous, and filled with fragments weathered from the underlying limestone. The principal vegetation is scrub oak. Occasionally the Buda limestone extends to the north as a reentrant tongue in the Del Rio area. Under these conditions it forms a cap which protects the underlying Del Rio clay from weathering.

The Austin Hills:

An area of low chalky, or marly limestone hills extends across Medina County in a general southwest-northeast direction till in the western part of the county, conformable to the other Upper Cretaceous formations, the Eagleford and Austin formations swing to the north. In general, the Eagleford area is not distinguished from the Austin area for the two formations are in general physically very similar. Occasionally, there is a narrow Eagleford valley, to the north of the Austin hills. This, however, has insufficient areal extent to warrant mapping. Recently weathered surfaces of the Austin formation afford low buff or white chalk hills. Upon further weathering the chalk mixes with humus and forms a deep black clay loam, which is a highly desirable soil for agricultural purposes.

The basal and harder phase of the Austin formation gives the most prominent relief, while the more marly or upper part of the formation sometimes weathers to a soil phase greatly resembling the Anacacho-Escondido plain. The chief natural growth on the hills is live oak trees and in the lowlands, mesquite in abundance.

The Anacacho-Escondido Hills and Plains:

The uppermost Cretaceous formation in Medina County affords two distinct types of physiography. This variation is due both to lithologic changes in the strata composing the formation, and to the protective capping of the Edwards flint which has been later deposited over the area.

In the eastern part of the county the Escondido formation is represented physiographically by flint-covered interbedded yellow-brown limestone and clay strata. This is particularly evident in the area between Castroville and Dunlay and from these points following the Southern Pacific Railroad to Noonan and Haass.

In the western part of the county, south and west of D'Hanis, similar conditions are found. The basal part of the Escondido is more marly in all parts of the county while the upper part is more calcareous. This to a great extent accounts for the Escondido hills in the southern half of the area of the Escondido outcrop. The increase in calcareous matter from east to west across the county, both in the Anacacho and the Escondido formations, is probably chiefly responsible for the greater number of hills in the western part of the county. In this part of the county, there is also much more Edwards flint in the Uvalde formation which caps and protects the strata from erosion.

To a great extent, structural conditions are responsible for the absence of Anacacho hills in the central part of the county. Through the entire central part of the county, the Anacacho has been faulted beneath the surface, thus eliminating the possibility of its forming hills.

Through the entire central part of the county the Escondido is represented by a broad flat plain with little relief. The soil is deep black clay loam, and highly productive.

Midway-Wilcox Hills and Plains:

The entire Midway group and the basal part of the Wilcox group, because of their calcareous content, form a range of hills across Medina County. Whenever observed there was found a covering of Edwards flint, varying from a thin veneer to deposits ten to fifteen feet in thickness. The entire Midway group is composed of impure limestone, while in the Wilcox the calcium carbonate is present in the nature of arenaceous limestone lenses which are common in the shale of the basal Wilcox. In the upper part of the group the shales predominate and afford a plain with little relief. The Midway and lower Wilcox weather to gray and reddish-brown, respectively, while the upper Wilcox weathers to deep blood-red. The soil of the Wilcox area from north to south increases in amount of sand. The chief growth is mesquite, but along the streams there are in addition some live oak trees.

The Carrizo Hills:

The surface exposures of the Carrizo formation weather to a plain with low hills. The entire area is deeply covered by a coarse gray-white sand. In some instances the higher hills are capped by Uvalde flint. As the exposed part of the formation is quite uniform physically, the physiography of the country is correspondingly uniform. Wherever the basal part of the formation is exposed in section it stands out as a deep red, coarse sand-hill not unlike the uppermost exposed Wilcox.

The vegetation is chiefly deciduous.

The Flood Plain:

Flood plains are present in Medina County, especially along the Medina and Hondo rivers. These formations are referred to the late Pliocene or Pleistocene and Recent. Sellards has distinguished three flood plains or terraces in the deposits of Bexar County which are later than Miocene in age, but no attempt has been made to carry this distinction into Medina County. The alluvial deposits in Medina County are all referred to the Leona formation and the area overprinted on the underlying geologic formations.

GEOLOGY

The surface rocks of Medina County belong to two distinct classes, dependent upon their origin. Those occupying practically the entire county are referred to the sedimentary class, because of their deposition as sediments. Those occupying in situ three small areas in the northern part of the county, having been intruded to their present position as molten magma, are referred to as igneous rocks.

Three divisions of the sedimentary rocks can also be made, dependent upon the type of sedimentation under which the deposition took place. The principal division is composed of those sediments laid down at the seashore or in the sea bottom, which are of marine origin. The second division is composed of those sediments deposited in fresh water, such as lakes, rivers and streams, and hence of lacustrine origin. The smallest division is made up of those sediments which were laid down on land by agencies other than water. These are generally almost unconsolidated and of Pleistocene or Recent age. The sediments of land origin include caliche, detrital material which has not been moved from the locality at which it was derived, and such associated materials.

The marine sediments belong to the Cretaceous and Eocene periods. The igneous rocks dating from the time of their intrusion, are very probably of Eocene age. It is not known at exactly what age the fresh water sediments were laid down but they probably range from late Pliocene through Pleistocene and Recent age. Deposition of this type is taking place to a great extent at the present time.

The land deposits are assigned to the Recent period. Deposition of this type is also occurring daily.

The total marine sediments of about 3600 feet are divided between the Cretaceous and the Eocene series, approximately 2800 feet being assigned to the Cretaceous and about 800 feet to the Eocene.

The fresh water sediments total approximately 100 feet and are referred to the Leona formation. Land deposited sediments range from a mere veneer to a thickness of 40 or 50 feet, and are included in the Uvalde and Leona formations.

THE GEOLOGIC MAP

AREAL GEOLOGY

The surface formations of Medina County are represented on the geologic map in as much detail as is practicable with the scale and accuracy of the base map.

The Uvalde and Leona formations which are alluvial material of Pliocene to Recent age, to a great extent form a mantle over the entire central half of the county. In thickness these formations vary from practically zero on the uplands to approximately 100 feet locally in the Medina and Hondo River valleys and banks.

In general, however, they appear as a thin mantle through which the underlying formations project with sufficient exposures to be accurately mapped. In mapping, the formations underlying the Uvalde and Leona have been shown in the positions which they occupy, and the Uvalde and Leona indicated by the overprint. This is considered the most satisfactory method since the chief object is to show as much of the geology of the county as possible. Only the thicker areas of the Uvalde and the Leona formations are shown, since a thin veneer covers most of the central part of the county.

The exposures of the underlying formations, though small, are frequent enough in occurrence to permit an accurate mapping of all the geological formations.

STRATIGRAPHIC GEOLOGY

Regardless of their origin all of the surface rocks in Medina County belong to the Mesozoic and Cenozoic eras. To the Mesozoic era belong the Comanchean and Upper Cretaceous systems with their numerous subdivisions. To the Cenozoic era belong the Eocene sediments and all later deposits. The igneous rocks also very probably came into their present position in the Eocene-Cenozoic and are consequently referred to as of Eocene age. With the exception of the Upson clay, no formation which is not exposed at the surface has been reached in any subsurface exploration. The Travis Peak formation of the Comanchean-Cretaceous undoubtedly underlies the Glenrose formation north of the Balcones Escarpment, as it has been reached in deep explorations in Bexar County, but so far as known there are no tests in Medina County deep enough to pass below the Glenrose limestone.

Pre-Cretaceous sedimentary material, possibly Carboniferous, may perhaps be reached under the Comanchean north of the Balcones Fault. It is probably not present in Bexar County but is present farther to the west and possibly has its eastward extension in Medina County.

Pre-Cretaceous schists were encountered along the Balcones fault zone in Bexar County. However, no test in Medina County has been carried deep enough to prove the presence or absence of these schists.

THE MESOZOIC

THE COMANCHEAN-CRETACEOUS

The Comanchean series of the Cretaceous, exposed in Medina County, is composed of some 1200 feet of limestones included in the Fredericksburg and Washita divisions. From the base to the top of the series, with one exception, there is a decrease in the amount of argillaceous and arenaceous material with a corresponding increase in the calcareous content.

The Del Rio clay near the top of the Comanchean is the exception to the general statement. The formations of the Comanchean-Cretaceous exposed in Medina County in ascending order are: the Glenrose, Walnut, Comanche Peak, Edwards, Georgetown, Del Rio, and Buda. Their position in the geologic column and their thickness are shown in Plate 1.

TRINITY DIVISION

The Glenrose Formation

The oldest strata exposed at the surface in Medina County belong to the Glenrose formation of the Comanchean-Cretaceous. Though considerably softer than the Edwards formation with which it generally has contact because of faulting, the Glenrose limestone has approximately the same physical characters as the intervening Walnut and Comanche Peak formations. The strata principally include moderately soft argillaceous and arenaceous yellow limestones which carry no flint. The alternating harder and softer strata in weathering give a banded appearance to the hillsides.

The more calcareous ledges are harder than those containing argillaceous material and, in weathering, project over the softer strata. In general, the harder ledges are from one to three feet in thickness, persistent over considerable areas, and quite uniform in texture. Although this average thickness of these limestone ledges is generally found, strata of a much greater thickness are often encountered. In localities these heavy limestone ledges are exceedingly porous and often honey-combed. Inside the cavities there are often replacements of crystal silica and occasionally of celestite.

Though the calcareous ledges are the most resistant strata of the Glenrose formation, they are distinctly softer and more susceptible to weathering than the Edwards limestone.

Alternating with the harder strata are ledges or horizons of soft, argillaceous, marly limestone. The ledges have a considerable range in thickness, varying from six inches to three feet. These ledges are composed of thin, marly laminæ from one-eighth to one-half inch in thickness. In weathering, these softer ledges tend to split along the bedding planes and to break into thin flags from two to four inches in length. The tendency on the whole is for these argillaceous ledges to develop a shaly appearance. There seems to be approximately an equal development of the calcareous and the argillaceous ledges. The calcareous, honey-combed ledges, though not universal in the formation, are nevertheless common; and without criteria from fossils, are difficult to distinguish from the non-flint-bearing ledges of the Edwards formation.

The general physical characters of the Glenrose limestone remain practically uniform throughout. There is about as much argillaceous matter in the base as at the top of the formation. No flint has been found anywhere in the Glenrose formation.

There is little difficulty in distinguishing between the Glenrose and the Edwards formations. Lithologically they are very distinct, with the exception of the honey-combed phase of the Glenrose and the non-flint-bearing part of the Edwards. Generally the yellow, soft, argillaceous or arenaceous, impure limestone interbedded with shaly marl ledges, is easily differentiated from the massive, hard, gray, flint-bearing Edwards limestone.

Paleontologically the Glenrose formation is very dissimilar to the Edwards limestone. The former is highly fossiliferous, especially in the marly ledges, while the latter is very poorly fossiliferous throughout. *Tylostoma pedernalis, Cyprina* sp., *Turritella* sp. (numerous), *Homomya* (abundant) cf. Cragin are common throughout the Glenrose formation and readily distinguish it from the Edwards formation.

About 150 feet of the Glenrose formation are exposed in Medina County and the identification of the remainder of the formation from well records is rather difficult. The thickness given for the formation in Bexar County, by Sellards, is 800 feet, and this is probably nearly the thickness of the formation in Medina County.

In a water well on the King Ranch in the northern part of Medina County, over 500 feet of Glenrose material were penetrated. The mouth of the well is approximately 200 feet below the top of the Glenrose formation. It is thus evident that there are over 700 feet of Glenrose limestone present in Medina County.

North of the main fault of the Balcones fault zone the area is almost entirely covered by the Glenrose formation. Small local outcrops of the Walnut and Comanche Peak formations are found in one locality in the fault zone to the north of the Edwards limestone area.

The topography of the Glenrose area is distinctive. The hills, though generally higher than those of the Edwards area, are much less rugged and have a banded appearance due to the alternating hard and soft ledges. There are practically no bluffs or cliffs on the Glenrose hills. The slopes are more gentle and support a much greater vegetation than the Edwards hills to the south. The soil of the Glenrose area is much deeper than the Edwards area and there is no flint in or covering the Glenrose formation. Two and seven-tenths miles north of the Nixon Ranch on the Utopia road the main fault of the Balcones fault zone was located within one-eighth of a mile horizontal distance.

On the south side of a narrow valley the massive, hard, gray, unfossiliferous, flint-bearing Edwards limestone is well exposed and one-eighth of a mile farther to the north, soft, yellow, marly fossiliferous limestone of the Glenrose formation was found. The Comanche Peak and Walnut formations have evidently been entirely eroded from the top of the Glenrose area and they were not found in the fault at this locality.

To the north of this locality, at least as far north as the Bandera County line, the entire area is covered surficially by the Glenrose formation. The topography, though showing much variation, has none of the rugged nature of the Edwards area. The slopes are quite gentle, grass-covered, and have none of the flint which is characteristic of the Edwards area.

At the first crossing of the Hondo River, one-half mile south of the Rothe Ranch, 16 miles north of Hondo, on the Hondo-Tarpley road, the Glenrose limestone is found in contact with the Walnut and Comanche Peak formations, north of the main Balcones Fault. The Glenrose area in this region is very readily distinguished from the Edwards area. The Edwards bluffs along the south bank of a small stream, which flows for a short distance in the fault, rise solid and massive for some seventy-five feet. They are the characteristic hard, gray, vertical bluffs of massively bedded flint-bearing Edwards limestone. To the north is found the soft, yellow, non-flint-bearing, fossiliferous Glenrose formation.

One mile south of the junction of Middle and West Verde creeks, the contact of the Edwards and the Glenrose formations is again found. At this locality the intervening formations are absent. The flint-bearing, massive, hard, gray Edwards limestone is faulted against the soft, marly, fossiliferous Glenrose formation.

Two miles east of south from the locality where the East Verde Creek crosses the Hondo-Bandera road, the contact of the Glenrose with the Edwards was again established. As far north as the fault itself, the surface is covered with large, pitted, flint-bearing, hard, gray, unfossiliferous boulders which in places cover the underlying bedrock of the Edwards formation. North of the fault there is no flint and the soft argillaceous limestone and marly ledges are highly fossiliferous with *Homomya* and *Tylostoma* sp.

The course of the water from Indian and Moccasin springs and the change of direction in the last half of the course of Cypress Creek, at once indicate some abnormal geologic condition. The remaining drainage of the surrounding area is to the south while the waters from Indian and Moccasin springs as well as Cypress Creek in the last half of its course, flow due east.

The main Balcones Fault is accountable for the change in the direction of drainage in this area. The two springs just mentioned have their origin in the fault and their waters follow east along the fault. Cypress Creek rises in the Glenrose area and in common with the other creeks of the area, starts on its course to the south. This course is continuous through the Glenrose area, but when the water meets the massive hard bluffs of the Edwards limestone along the south side of the north fault of the main Balcones fault zone, the course of the creek is directed to the east along in the fault itself, as are the waters from Indian and Moccasin springs.

On the south side of a draw which carries the waters of Indian and Moccasin springs and which is the course for the last one and a half miles of Cypress Creek, the massive bluffs of the hard, gray, flint-bearing Edwards limestone stand practically vertical for 60 to 70 feet. On the north of the draw are the soft, yellow, fossiliferous Glenrose strata.

Two miles northeast of the main dam on the road to Bandera, the contact of the Glenrose and the Edwards is found. Both of these formations have typical exposures within one-eighth of a mile. There is no difficulty in placing the position of the contact at this point.

Again on the road north from Cliff to the Galligher ranch, two miles north of Cliff, the massive Edwards limestone is found faulted against the yellow, thin-bedded, fossiliferous Glenrose formation. To the north, the entire area in Medina County is covered by the Glenrose formation.

FREDERICKSBURG DIVISION

The Walnut Formation

Only a limited amount of the Walnut clay is exposed in Medina County. The exposures also occur under very different geological conditions.

On the Tarpley road, 16 miles north of Hondo and one-half mile south of the Rothe Ranch, the Walnut clay is found in the south bank of the creek. The base of the formation could not be seen but some fifteen feet of medium soft, calcareous clays were found at the north wall of the main Balcones Fault. North of the clays exposed at this locality, the Glenrose limestone is exposed over the entire area. Over the Glenrose area to the north, there is no Walnut clay exposed. It, as well as the overlying formations, has been eroded, leaving only the Glenrose at the surface. Immediately to the south of the main Balcones Fault, the Walnut clay is found under the Comanche Peak formation, which in turn underlies the Edwards limestone. The entire displacement of the faulting has not been sufficiently great to prevent the drainage at this point, flowing in the fault, from exposing the Walnut clay, though this exposure is only very local. To the south, the formation is covered by the overlying Comanche Peak and Edwards limestones.

Most of the Comanche Peak strata exposed in this area are highly tilted to the south, indicating that the greater part of the exposure is due to the drag in the fault of the downthrown side to the south. Thus the Walnut clay is exposed just south of the foot wall of the Balcones Fault and it dips steeply to the south and under the younger formations. At this locality, the Walnut clay is exposed for about a mile along in the main Balcones Fault. The probable increase in the throw of the fault, the absence of practically any heave, with the accompanying drag of the downthrown side and the less developed drainage at this locality in the fault are all directly responsible for the termination of the outcrop.

The Walnut formation here exposed consists of medium hard, calcareous clays or marls with some arenaceous matter. At the bottom of the exposed section the clay is more argillaceous, and becomes more calcareous and slightly nodular towards the top. It grades imperceptibly into the overlying nodular Comanche Peak limestone.

Throughout the Walnut clay there is an abundance of the oyster, *Exogyra texana,* which is characteristic of this formation. Associated with it are *Gryphea pitcheri, Echinoid* sp., *Cypricardia texana, Pholadomya* sp., *Turritella* sp., *Gastropod* sp., *Homomya, Protocardia,* and *Tylostoma pedernalis.*

On the Medina River in the vicinity of the main irrigation dam the Walnut formation is again exposed. In this locality its appearance in the lower wall of Medina River is due almost entirely to the more highly developed drainage of the region. South of the main Balcones Fault, the Medina River has cut through the Edwards limestone which covers the surface and has exposed the Comanche Peak, Walnut and Glenrose formations, respectively, underlying the Edwards limestone. The Glenrose is only very locally exposed in the base of the bluffs and in the river bed. Over it are about twenty feet of Walnut clay, containing *Exogyra texana* in considerable abundance, together with other associated Walnut clay fossils.

The twenty feet of section exposed in the Medina River banks very probably represent practically the entire thickness of the Walnut formation in Medina County.

The Comanche Peak Formation

Under geological conditions practically identical with those discussed as determining the amount of the Walnut formation exposed in Medina County, are found similar exposures of the Comanche Peak formation.

Immediately to the south of the foot wall of the main Balcones Fault are some 30 or 35 feet of argillaceous nodular limestone overlying the Walnut formation. The Comanche Peak formation is likewise exposed because of the same structural conditions which govern the amount of Walnut clay exposed at this locality. The drag toward the downthrown side of the fault, together with considerable heave, has given approximately equal exposures of both the Walnut and Comanche Peak formations.

In section, the Walnut clay gradually grades upward with a loss of argillaceous matter and an increase in calcareous content, into the nodular Comanche Peak limestone. There is no definite demarcation between the two formations but in a vertical section of five feet at the top of the Walnut clay there is a distinct change. The paleontologic contrast is much more noticeable than the lithologic change. Most of the Walnut clay fauna disappears and with the exception of *Gryphea pitcheri*, an undetermined *Ostrea* sp., and a pelecypod resembling *Homomya*, no fossils were obtained from the Comanche Peak formation. The sudden termination of *Exogyra texana* which is so abundant in and characteristic of the Walnut formation, together with the associated fauna, denotes a change between the Walnut clay and the Comanche Peak limestone which is more abrupt than anything suggested by the lithologic transition.

In the base of the bluffs of the Medina River in the vicinity of the main irrigation dam, the Comanche Peak limestone is found overlying the Walnut clay. There is no distinct physical break between the Comanche Peak limestone and the underlying Walnut clay or the overlying Edwards limestone. Though a section of 5 to 10 feet at the contact between any of the formations from the Glenrose to the Edwards shows considerable physical dissimilarity between its base and its top, it is difficult to define to a foot or less, the contact between any of the formations just mentioned. At its top the Comanche Peak limestone becomes more massive and the nodular characters disappear. Again, without any distinct break the Edwards limestone overlies the Comanche Peak formation.

To the Comanche Peak formation there is then assigned approximately thirty feet of nodular material overlying the Walnut clays which carry *Exogyra texana*, and underlying the massive, hard, gray, flint-bearing Edwards limestone.

WASHITA DIVISION

The Georgetown-Edwards Formation

Although it is recognized that in Medina County there are about 40 feet of Georgetown limestone overlying the

Edwards formation, all the material between the Comanche Peak and the Del Rio formations has been included in the Georgetown-Edwards formation. In Medina County there is insufficient lithologic dissimilarity to warrant the distinction upon physical characters alone. Also insufficient data regarding the range of the respective faunas of the Edwards and Georgetown formations have been obtained to make practicable the distinction upon paleontologic criteria. *Kingena wacoensis* Roemer is supposedly characteristic of the Georgetown formation, but not enough specimens were found to define the Georgetown limestone as a mappable unit. This fossil has also been found in Medina County and in Uvalde County in limestone which is quite evidently of Edwards age.

The Georgetown formation is generally considered to be a non-flint-bearing formation, but in Medina County flint has been found in the limestone 15 feet below the Del Rio formation. There are also horizons of considerable thickness where at least locally the lower part of the Edwards formation carries no flint. For these reasons the Georgetown formation has not been mapped separately but included as the upper 40 feet of the Georgetown-Edwards formation.

Throughout its entire thickness the Georgetown-Edwards is a remarkably uniform formation of massive, heavy, irregularly-bedded and jointed, gray limestone, generally carrying considerable flint. In the basal 50 feet there is some nodular material which becomes more argillaceous toward the bottom of the formation, where it is distinguished with difficulty from the uppermost nodular calcareous Comanche Peak limestone. The fossils of the two formations are easily distinguished. About 50 feet above its base, the Georgetown-Edwards formation loses its nodular texture and becomes more calcareous and dense. In the basal nodular part there is considerably less flint. With the decrease of the argillaceous matter the limestone becomes more calcareous and flint-bearing. The flint is generally present as oblong concretions approximately six inches thick and from one to two feet long. There is also much chert in the form of lenses six to eight inches thick and sometimes as much as 12 to 15 feet in length. Most of these lenses are not over six feet in length. The color of the chert is generally dark gray, light blue-gray, and slightly bluish-black. This chert in many instances has entirely replaced the fossils of the Georgetown-Edwards formation and it is from this formation that the flint of the Uvalde formation is obtained. Several Edwards fossils, principally *Pectens,* have been obtained from the Uvalde flint in the south and southwestern part of Medina County.

Though there are flaggy and argillaceous phases of the Georgetown-Edwards limestone, the great part is medium fine-grained and crystalline. Wherever the argillaceous matter is present the limestone is more yellow in color, instead of a blue-gray or gray.

The Georgetown-Edwards formation is moderately massive-bedded. The individual beds generally average three to four feet in thickness, though in localities they are more nearly one foot thick. This thin-bedded phase is generally found where the amount of clay in the limestone increases. As a rule the bedding is quite even, at least locally, and the joints, though not as well defined as those in the Austin chalk, are quite distinct. The moderately thick bedding and medium interval of jointing cause the limestone to weather into boulders which are two to three feet in diameter. Almost universally the limestone in weathering develops a pitted or channelled appearance. This type of weathering is due to the solvent action of rainwater falling upon the often heated rock surface. The solvent action generally is most effective along the joints, however small or immature they may be. When fractured, the limestone generally breaks along the small channels weathered in the surface. This is due not so much to the weakening of the rock along these lines from solvent action of water, as to the fact that the position of these surface channels has been determined by the joints in the rocks. Within the large limestone blocks which have become detached from the main rock body, there are series of joints becoming finer and finer till the last recognizable set generally includes a portion of rock not over an inch square. It is along the joints that rainwater has the best access and consequently there is more calcium carbonate dissolved from the rock along the surface strike of the joints.

The compactness of the Georgetown-Edwards formation except in the lower argillaceous 50 feet, produces a characteristic ringing sound when struck with a hammer. Upon exposure to weathering the rock does not soften rapidly and in some cases seems to be even harder than when detached.

Over the entire Georgetown-Edwards area the surface topography is exceedingly rough and varied. The rough, pitted, and channelled appearance of the boulders and bed rock itself adds considerably to the broken relief of the region. Without exception the area of surficial outcrop of the Georgetown-Edwards limestone is the roughest and most broken country in Medina County.

Over this area there is a great amount of flint derived from the Georgetown-Edwards limestone. When these flint-boulders are exposed for any considerable time, they are covered by a thin film of calcium carbonate and are stained to a deep red from oxidation of the contained iron. The boulders vary from mere pebbles an inch or two in diameter to masses three or four feet in diameter and weighing several hundred pounds.

Since the stream drainage is to the south, the detrital material from the Georgetown-Edwards formation, chiefly flint, is found as a mantle covering the more recent formations to the south. Also since the drainage is in this direction and the Glenrose formation lies to the north and contains no flint, the absence of flint on the surface to the north of the Georgetown-Edwards area denotes the proximity, if not the actual presence, of the Glenrose formation. In this connection the Walnut clay and Comanche Peak formations have too small an areal exposure to be an important consideration.

The origin of the chert of the Georgetown-Edwards formation is chiefly from siliceous agencies, probably silicispongae inhabiting moderately warm water of a medium depth in the Cretaceous sea which existed when the Georgetown-Edwards formation was being deposited. The presence of some argillaceous material in the Georgetown-Edwards limestone as well as the siliceous matter from the sponges, denotes medium depth of water conditions, sufficiently far from shore to permit quiet deposition chiefly of calcium carbonate, yet close enough to shore to permit the growth of sponges and the deposition of some argillaceous matter.

The limestone of the Georgetown-Edwards formation is quite cavernous. In some instances these caves are of considerable size and when at sufficiently low elevation sometimes permit small underground streams to reach the surface as channel or fissure springs.

In surficial extent the Georgetown-Edwards formation covers slightly more area than the Glenrose limestone, from which it is sharply defined lithologically, paleontologically, and structurally. The main fault of the Balcones fault zone extending south of west across the northern end of Medina County, denotes the contact of the Georgetown-Edwards limestone with the Comanche Peak formation, or, in the absence of the Comanche Peak and Walnut formations, through faulting, this main fault denotes the contact of the Georgetown-Edwards with the Glenrose formation. The contact of the Georgetown-Edwards with the older formations on the north is marked by the northernmost fault of the Balcones fault zone. Minor faulting also delimits in places the southern extension of the Georgetown-Edwards formation. The excessive faulting in the vicinity of, and to the east of, Medina River, is responsible for the comparative size of the formation outcrops east and west of the river.

The topography of the Georgetown-Edwards belt is exceedingly rough and broken. This geologic and physiographic belt maintains a width of approximately six miles, across the greater part of the county west of Medina River. West of Seco Creek it narrows rapidly and at the western county line only some two and one-half to three miles of areal width are exposed. East of the Medina River the

Georgetown-Edwards belt uniformly widens from one mile at the Medina-Bexar County line to two miles wide at the Medina River.

The vegetation of the Georgetown-Edwards is characteristic of the distinctly broken and hilly country. The soil, with the exception of the stream valleys in which are concentrations of the Georgetown-Edwards soil enriched by older and more argillaceous material from the north, is poor and thin, and supports a scanty vegetation. The native vegetation is chiefly small oaks, cedars, and, on the lower slopes, some mesquite. The soil of the uplands is highly calcareous and where the surface has much flint as a mantle, the soil is distinctly red. In nearly all places the bed rock projects through the thin soil mantle. There is, generally, sufficient soil to support a good grass under a moderate amount of rainfall. The uplands are desirable ranch lands while the valleys can be utilized for farming.

The fossils of the Edwards division of the Georgetown-Edwards formation are not abundant, but *Requienia texana* Roemer, *Monopleura* sp., and *Radiolites* are quite frequently found. The Rudistid family comprises the greater amount of the common fossils. In the upper Edwards and in the Georgetown formation, *Kingena wacoensis, Gryphea pitcheri,* with some *Radiolites,* are found.

The average thickness of the Georgetown-Edwards formation in Medina County is about 500 feet.

The Del Rio Formation

Probably the most readily identified formation in Medina County is the Del Rio clay. Both the physical and biologic characters are constant throughout the county and no difficulty is experienced in the identification of the formation. The position of the Del Rio clays above the hard, massive, gray-white Georgetown-Edwards limestone and below the buff-colored, nodular Buda limestone also assists in its identification. For the most part, the Del Rio formation consists of soft, slightly arenaceous clays. In subsurface explorations, the material is generally light blue in color but on weathered surfaces it is predominantly yellow, though often stained to a dark brown or red by oxide of iron. Interbedded in the soft shales are harder layers of calcareous clays, which in some instances are consolidated into argillaceous limestones. These limestone layers are generally from three to four inches thick and weather into large brown flags about one and one-half to two feet long and two to three feet wide. These flags are found mainly in the lower part of the formation.

In addition to the general lithologic characters of the Del Rio formation and its position in the geologic column, both of which make its distinction evident, there are two criteria which are peculiar to the Del Rio formation in Medina County. The abundance of the small oyster *Exogyra arietina* which is confined to the Del Rio formation is a definite means of identification. No exposure of the Del Rio was found in Medina County where there was not an abundance of this small oyster. On weathered slopes the ground is generally covered with this fossil.

Pyrite of iron in the unweathered blue clays of the Del Rio formation, which decomposes, upon exposure, to flat nodules of limonite approximately one-half inch wide by one inch long, has been found wherever the Del Rio clay outcrops in Medina County. At all exposures found, the surface which is underlain by the Del Rio clay is covered with these flat limonite nodules. In passing over the country the presence of the Del Rio formation can at once be detected by the appearance of the limonite. Toward the outcrop of the Del Rio the amount of limonite increases and mixed with it are numerous *Exogyra arietina.* Thus most of the surface exposures are of yellow clay covered with limonite particles and numerous specimens of *Exogyra arietina.* In some instances the calcareous clays in the form of flags containing *Exogyra arietina* are found. These flags are really masses of *Exogyra arietina* held together by a calcareous clay.

In addition, the fossil *Nodosaria texana* is quite common as are numerous small gastropods and pelecypods. In many instances the fossils are replaced by limonite. It is quite probable that the original replacement of the fossil was iron pyrite which has later been changed to limonite. The delicate markings of the surface of the fossils are generally destroyed, as would be expected. Close observation of the unweathered material would determine if the original replacement is iron pyrite, as considered, or if, as seems less probable, the replacement has taken place since the iron pyrite has been changed to limonite.

The diminutive size of the fossils of the Del Rio, and especially in the upper part, since they are associated with much iron pyrite, indicates that the chemical conditions in the waters in which these fossils lived were conducive to retardation of growth in the fossil life. These conditions resulted in a dwarfed fauna associated with iron pyrite or its weathered form, limonite. Similar conditions have been observed in the Paleozoic formations of New York State, and recently Adkins[3] has encountered identical results in the Weno and Pawpaw formations of north Texas.

West of Hondo River the Del Rio formation occupies a surface width of from a quarter to a half mile and at all places it is readily traced upon the surface. A half mile south of the Nixon Ranch these fossiliferous limonite-bearing clays are exposed at the side of the road. Here as usual they occupy a narrow belt, a topographic valley between the Georgetown-Edwards hills on the north and the Buda limestone on the south. Various exposures affording from five to ten feet of vertical section are found between Nixon's Ranch and the Hondo River.

On the Hondo River the Del Rio formation outcrops for slightly over a quarter of a mile north of the Buda area. The presence of these inliers is due to the small amount of overlying Buda limestone, its horizontal position, the presence of two small faults, and the Hondo River which has cut through the overlying Buda formation.

North of the main Buda exposure on the Hondo River, the Del Rio formation is more calcareous and fossiliferous, and weathers to medium hard brown flags. The section is:

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[3]Adkins, W. S., The Weno and Pawpaw Formations of the Texas Comanchean. Univ. Texas Bull. 1856.

	Feet
Alluvium.	15
Buda, very nodular	20
Del Rio clay, variegated, *Exogyra arietina*, *Lima*, etc.	5

To the south, in the upper part of the formation, the clays are yellow to brown and are exposed in the bed of Hondo River or in the lower part of its banks. Here also the formation carries *Exogyra arietina* in abundance together with much limonite.

The northern fault at the above locality in the Buda formation, on the Hondo River, with a ten foot displacement and downthrown to the south, exposes the top of the Del Rio clay in the wall on the north side of the fault.

East of Verde Creek the surface exposures of the Del Rio formation reach a maximum of three and one-half miles. In this area, however, there are re-entrant tongues and outliers of the Buda limestone in the Del Rio area and inliers of the Del Rio in the Buda area. Block faulting, which in localities has placed the strata practically horizontal, is the chief reason for the increased surface exposure as well as the re-entrant tongues, outliers and inliers.

From five and one-half to eight and one-half miles slightly west of north from Quihi, good exposures of the Del Rio formation are found and the contacts of the Del Rio with the Buda and the Georgetown-Edwards are evident.

In a west-facing escarpment five and one-half miles from Quihi, on the Hondo-Bandera road, a good exposure of the Del Rio and the contacts between the Del Rio and the overlying Buda limestone are seen. In this escarpment 600 feet east of the road, there are 25 feet of yellow-red clays, carrying *Exogyra arietina* and limonite in abundance. Overlying the clay there is a cap of eight feet of hard Buda limestone which forms the rim of the small escarpment. From this locality on either side of the road, for approximately one mile, re-entrant tongues of the Buda form the cap rock of the ridges and protect the Del Rio clay below. The outliers on the Hondo-Bandera road eight miles west of north from Quihi are capped with five to ten feet of hard, gray, nodular Buda limestone. The fifteen to twenty feet of exposed material underlying the Buda are the yellow and red clays of the Del Rio. At this locality the clays are normally very fossiliferous and ferruginous.

A thousand feet north of the most northern outlier of Buda is the hard, gray, pitted, flint-bearing Georgetown-Edwards limestone. Between these two points the valley is occupied by the Del Rio clay.

Seven miles west of Medina River there is a fault trending west of north and east of south which narrows the Del Rio surface from three and one-half miles on the west of the fault to one-half mile on the east of the same fault. This decrease in areal extent of the Del Rio east of the fault is compensated by the extension to the south of the Georgetown-Edwards limestone.

East of Medina River the Del Rio is faulted below the surface. Throughout its entire surface extent the Del Rio formation is topographically a shallow valley between the Georgetown-Edwards hills on the north and the Buda hills on the south. In general, the width of the valley is from one-fourth to one-half mile, but wherever the Del Rio has been faulted so that there is a greater surface exposure, the Del Rio valley or plain is correspondingly wider. No surface exposures of the entire thickness of the Del Rio formation are present in Medina County. However, the data from numerous water wells show that the Del Rio clay is quite uniformly 60 feet thick throughout the country.

The Buda Formation

At the top of the Comanchean Cretaceous and immediately underlying the Eagleford formation of the Upper Cretaceous, is the Buda formation. The Buda limestone because of its physical qualities is well exposed in Medina County, though the thickness of the formation is not considered to exceed 60 feet. The strata which compose this formation are uniformly of a dense, buff or light gray, fine-grained, hard limestone, which is cut by thin veins of white calcite. In color the rock varies from light gray tinged with blue or yellow, to a buff color, and is sometimes blotched with red. Regardless of color, the texture remains constant. The homogeneous Buda limestone has a persistent, smooth, conchoidal fracture and is generally distinctly nodular. In some localities, such as at the crossing of the Seco Creek, half a mile west of Rothe's gate on the D'Hanis-Utopia road, the strata are composed of hard, calcareous, discoidal nodules in a matrix of softer calcareous material. Upon breaking, these nodules free themselves from the softer material, and on a freshly weathered surface the detrital matter is usually small double convex nodules from four to five inches long and about the same dimension in width. There is no difficulty in distinguishing the Buda limestone from either the underlying Del Rio clay or the overlying Eagleford marl or shale. It is exceedingly individual in appearance and shows no lateral variation within the county.

From numerous surface measurements and from data obtained from well logs, the Buda limestone apparently does not vary greatly from the average 60 feet in thickness. It is found with a surficial exposure of from one to three miles across the county west of Medina River. To the east of Medina River, the faulting which has placed the Austin against the Edwards formation has eliminated the Buda along with the Del Rio and Eagleford formations.

Although the Buda limestone is exposed in a belt approximately one mile wide, lying just south of the Del Rio formation west of and between Seco Creek and the Uvalde and Medina County lines, and between Seco Creek and Hondo River, the best exposure is found in Seco Creek, one-half mile east of Rothe's gate on the D'Hanis-Utopia road. At the north of the road in the west bank of Seco Creek, 30 feet of light buff to cream-colored, exceedingly nodular, unfossiliferous limestone are exposed. The dip of the strata is 1-½° N. 50° W. In this locality the nodular phase of the Buda limestone seems to be developed to a greater extent than in any other place in the county. Practically the entire section is nodular. The lower 20 feet of the Buda are distinctly less nodular than the remaining 40 feet.

Throughout the Buda section at all localities the conchoidal fracture and the presence of thin veins of white calcite in the strata are characteristic of this formation.

There is in all probability a small fault at the northern end of the Buda outcrop on Seco Creek. The dip of 1-½° N. 50° W. and the sudden termination of the Buda in a vertical bluff postulate a fault at this place. Though no good exposures adequate for sectioning are present between Seco Creek and Hondo River, the Buda limestone maintains its average width of one mile of surface exposure. A quarter of a mile west of Hondo River, the same faults which give the Austin chalk a horizontal displacement of approximately one mile, afford three times as great a surface area of Buda east of the faults as is found west of the same fault. The Buda, though not extending so far to the north on the east side of the fault, has contact with the Austin and the Anacacho formations along practically their entire eastern surface exposures west of the fault. It is evident that block faulting with both vertical displacement and inclination of the block has occurred. The surface area of three miles in width for a formation of 60 feet thickness whose normal areal exposure is one mile, and the exposure along the Hondo River of the underlying Del Rio formation in the base of the river banks, together with observations on the dip of the limestone, show that the Buda is practically horizontal over this area.

Two faults in the bed of Hondo River two miles north of Hondo parallel to the strike of the Buda formation, the northernmost one with a vertical displacement of about 10 feet, and the southernmost one with a vertical displacement of 50 feet, practically fix the southern limit of the Buda limestone. The downthrow of these faults is to the south. The northern fault in the Buda formation, with a displacement of 10 feet and a downthrow to the south, exposes the top of the Del Rio clays in the base of the wall underlying the Buda on the north side of the fault. On the north of the fault the Buda limestone dips 2° to the north, while south of the fault its dip is 3° in the same direction. A quarter of a mile below the lower fault, which has a downthrow of 50 feet to the south, the strata are horizontal. However, they increase rapidly in dip to the north, reaching a maximum of 6° immediately south of the fault. North of this fault the dip is 2° to the north.

On Hondo River the Buda has the same conchoidal fracture and small calcite veins that are characteristic of the formation in other outcrops, but to a great extent the nodular phase is absent. The strata are evenly bedded and the bedding planes are from two to three feet in thickness.

Upon freshly exposed surfaces the limestone is gray with a tinge of blue, or creamy-brown in color. On surfaces which have been exposed for some time, the rock is much darker.

Practically the entire thickness of the Buda formation is present on the Hondo River and on the lower part of Verde Creek the contact of the Buda and the Eagleford formations is quite evident. The narrowing of the surface exposure of the Buda from three miles on the east side of the fault block crossed by the Hondo-Bandera road to a half mile on the west side of the block, indicates an abrupt steepening of the dip to the west, due to an inclination of the block by a fault with a trend northeast and southwest, as indicated. No minor faults of such a nature could be determined in this exact locality. The widening of the surface exposure of the Buda east of the northwest and southeast fault at this locality and the narrowing of the surface exposure of the formation to the west show that conditions in this block are very similar to those in the next block to the west.

For seven miles east from the Medina River, the Buda has its normal width of surface exposure, but on the south side, through northeast-southwest faulting, the Buda is in contact with the Escondido, the intervening formations having been faulted out.

East of Medina River the Georgetown-Edwards formation and the Austin chalk are in contact, while the Del Rio, Buda and Eagleford formations are faulted out. Thus the Buda limestone does not occur in Medina County, east of Medina River.

The Buda formation because of its uniform hardness and its position between two softer formations, is marked in the topography of the county by a belt of low rough hills varying from one to three miles in width. In some localities the surface is covered with medium-sized boulders, but in localities where the Buda is nodular the surface is strewn with small double convex fragments which are the nodules weathered from the matrix of the formation. The Del Rio valley to the north of the Buda area is considerably wider than the narrow Eagleford valley to the south. The thickness of the Del Rio formation in comparison with the Eagleford is the principal reason for the wider valley to the north of the Buda ridge.

The fossils of the Buda limestone are difficult to extract because of the hardness of the rock and the mineralization which has occurred. In some places the entire fossils are replaced by white calcite. The fauna of the Buda as represented in Medina County is quite limited. *Glycimeris* sp., *Pinna* sp., *Ostrea,* and some small echinoids were the only fossils obtained.

THE UPPER CRETACEOUS

Overlying the Comanchean in Medina County is a deposition of approximately 1300 feet of the Upper Cretaceous series. There is a strong contrast in the nature of the sediments composing the Upper and Comanchean (Lower) Cretaceous series. The Upper Cretaceous is composed of argillaceous chalky limestones, becoming more marly and arenaceous toward the top, and in some instances there are clay or sandstone strata, chiefly in the uppermost formation. The Comanchean-Cretaceous, as previously described, is chiefly composed of hard, gray, massive limestone. The formations of the Upper Cretaceous exposed in Medina County in ascending order are: The Eagleford, Austin, Anacacho, and Escondido.

The Eagleford Formation

The basal formation of the Upper Cretaceous has a smaller surficial area than any formation in the county with the exception of the Walnut clay and the Comanche Peak limestone. Faulting in the area in which the Eagleford is exposed, as well as the thickness of the formation itself, is partially responsible for the limited areal exposure. Even on surface outcrops it is quite difficult without detailed examination to distinguish the Eagleford and the Austin formations. The Eagleford formation is more nearly a collection of calcareous and arenaceous shales. Toward the top of the section the strata are more marly or chalky and very closely resemble the Austin chalk. In the basal and middle parts there are distinctly argillaceous strata.

On Hondo River the Eagleford section totals about 30 feet and this is very probably about the maximum thickness in the county. In the Medfrio test the blue sandy shale immediately underlying the Austin formation is referred to the Eagleford.

In surficial exposures the Eagleford formation is generally found wherever the base of the Austin chalk is exposed. In the area for some seven miles west of Medina River, both the Austin and the underlying Eagleford are missing. The block which underlies this area has evidently been elevated and the fault between the Buda and the Escondido has eliminated the intervening formations. The principal exposure of the Eagleford formation is on Hondo River, three and one-half miles north of Hondo. At this locality it is found resting upon the Buda limestone and underlying the glauconitic phase of the Austin formation. So far as known, there is no glauconite in the Eagleford formation in Medina County. The 30 feet of the Eagleford formation on Hondo River are composed of argillaceous and arenaceous shales becoming more calcareous toward the top, and passing into material which very much resembles the Austin chalk. It is, however, more arenaceous, and carries no glauconite.

Paleontologically there is little similarity between the Eagleford and the Austin formations. The great variety and abundance of forms which later were present in Austin times are only poorly or not at all represented in the Eagleford. The few *Inocerami* of the Eagleford are a distinct contrast to the numerous species and the abundance of specimens of the same genus in Austin times. The *Gryphea, Turrilites,* ammonites and *Exogyra* of the Austin chalk seem not to have been represented in Eagleford times. The sharks and fishes of the Eagleford seem to have almost completely disappeared by the beginning of Austin deposition. In Medina County good specimens of shark's teeth are rare in the Eagleford shales. In most instances the actual teeth have been replaced by soft powdery limonite. These casts of the teeth, in outlines representing the shape of the tooth, are common and almost always are filled with soft powdery limonite resembling iron rust. Occasionally a perfect specimen of the actual tooth is found. Fish scales too are plentiful and are found associated with the shark's teeth. With the exception of the fossils mentioned above and these shark and fish remains no animal life was found in the Eagleford formation.

On Seco Creek some hard, flaggy, light brown, arenaceous limestone belonging to the Eagleford was found. These flags are from one to three inches in thickness and two to three feet in width. They are quite hard and brown in color. Generally they show a banded structure when freshly broken. The flags are practically unfossiliferous with the exception of an occasional fish scale. From their position with respect to the Buda limestone, these shales are undoubtedly from the basal part of the Eagleford, though no actual contact between the Buda and the Eagleford could be obtained.

On surface topography the Eagleford is difficult to distinguish from the Austin, because of the lithologic similarity of the two formations. It is, however, usually found as a narrow flat or valley just north of the Austin outcrop.

The Austin Formation

As the entire thickness of the Austin chalk is not exposed in Medina County, measurements of this formation are confined to data obtained from well logs. The thickness attributed to the Austin chalk in Bexar County to the east and Uvalde County to the west affords a check upon the measurements in Medina County. Though there is some variation in the thickness of the formation at different localities, Sellards[4] has assigned an average thickness of 350 feet. In Uvalde County, Vaughan[5] considers the thickness

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[4]Sellards, E. H., Geology and Mineral Resources of Bexar County. Univ. Texas Bull. 1932.

[5]Vaughan, T. W., Uvalde Folio. U. S. Geol. Surv.

of the chalk to be between 350 and 400 feet, probably nearer to 400 feet.

In Medina County it is quite possible to determine from well logs within 50 feet of the thickness of this formation. The chalk is readily distinguished from the Upson clay or Anacacho limestone above. However, there is great difficulty, even at surface exposures, in determining the contact between the Eagleford formation and the overlying Austin chalk. Unless samples are obtained from the tests, it is practically impossible to ascertain from a log the depth at which the Eagleford formation is reached. Lithologically, the two formations are almost identical on surface exposures, though there is slightly more arenaceous matter in the Eagleford formation. The presence of fish scales and sharks's teeth readily identifies the formation when samples or outcrops are examined. However, since the Eagleford formation in Medina County is only 30 to 35 feet thick, its inclusion in the Austin chalk would involve only slightly more error than the variation in the thickness of the formation itself.

Below the Eagleford formation, the Buda limestone is so distinctive that confusion is practically impossible. The thickness of strata between the base of the Anacacho limestone and the top of the Buda limestone in Medina County is approximately 400 feet. Allowing for the 30 or 35 feet of Eagleford material and the possible 15 to 20 feet of Upson clay, there are about 350 feet of Austin formation in Medina County. The Austin formation is composed of a deposit of soft chalky limestone and marl. In some places there are partings which could be more correctly referred to as argillaceous shales or clays. Near the top of the formation, however, the material is more nearly a chalky limestone. With the exception of the more argillaceous layers, the formation is quite uniform, and when at the surface is generally represented by a light yellow or buff-colored, vertical cliff. In the lower half of the Austin formation from the Bexar County line on the east to at least as far west as Hondo River, there are ledges which are highly glauconitic. West of Hondo River the basal part is either practically all concealed by the Leona formation, or faulted below the surface. Though generally soft, the chalk is sometimes distinctly indurated. This is generally the case where there is more calcareous material and less argillaceous matter. As a rule, the bedding is moderately massive, single beds generally averaging from three to five feet in thickness. The systems of jointing also are quite well developed; one set approximately at right angles to the other.

Especially in the upper part of the Austin formation, are numerous cylindrical accretions of iron pyrite. Upon fracturing, when unweathered, the accretions show a beautiful radiating, crystalline structure; all of the individual crystals in a single plane radiating from a common central point located in the longer axis of the accretions. Without an exception, all of these cylindrical iron pyrite accretions were found to stand with their longitudinal axis perpendicular to the bedding planes of the Austin chalk. This unique type of accretion and manner of occurrence of iron pyrite are apparently characteristic of the upper half of the Austin chalk. Upon weathering, the iron pyrite decomposes to limonite, with a loss of sulphur which probably is accountable for the hydrogen sulphide in the water of some wells which obtain their supply from this formation.

The Austin formation throughout the entire exposed thickness is very fossiliferous, both megascopic and microscopic fossils being present. If studied in detail undoubtedly a number of key horizons could be established. Two horizons, however, have been established in the present work—one upon a physical basis entirely, and the other from paleontologic criteria.

The basal seventy-five feet of the Austin formation are generally quite highly indurated and in many respects resemble the Buda limestone. The white calcite veins which characterize the Buda, however, are absent, and the paleontologic data at once distinguish the two formations. The horizon determined on lithologic data, though not as definite and readily identified as the paleontologic horizon, is of considerable value in determining elevations in the basal part of the Austin chalk. Approximately 275 feet above the base of the Austin formation there is a four to five foot horizon which is composed of practically nothing but the shells of *Gryphea aucella.* These fossils are in an excellent state of preservation and when the matrix is slightly weathered or naturally less indurated, almost perfect specimens can be obtained in practically any numbers.

The *Gryphea aucella* horizon, as nearly as can be determined, occupies the same position in the Austin chalk across Medina County, and in fact the same horizon has been traced entirely across Bexar County to the east.

Immediately below the *Gryphea aucella* horizon on Hondo River there is a horizon of *Inocerami* but this horizon was not found at any other locality.

The presence of glauconite in the lower 275 feet of the Austin formation, at least as high as the top of the *Gryphea aucella* horizon, is scientifically important in determining the foraminiferal origin of the greater part of the formation. If, as is generally conceded, glauconite, a silicate of iron and potassium, is derived from the internal casts of foraminiferal organisms, there is little doubt but that the greater part of the Austin formation is of foraminiferal origin. The Austin formation is full of foraminifera, but it has been a subject of controversy whether or not these organisms were present in sufficient numbers to form a deposit of such thickness. So far as known, this is the first glauconite which has been reported from the Austin formation. The amount and range of this greensand indicate that the agents responsible for its origin and deposition were the chief factors in the development of the Austin formation.

The principal fossils which were collected from the Austin chalk was: *Inoceramus* sp., *Hemiaster* sp., *Ostrea* sp., *Exogyra ponderosa* (Austin variety), *Ostrea larva, Anomia* sp., *Turrilites* sp., *Nautilus* sp., *Gryphea aucella, Baculites* sp., and *Ammonites* sp. *Textularia* and *Globigerina* are the most common microscopic fossils.

Good exposures of the Austin formation are so numerous that it is impracticable to list them all. Only a few of the more important localities will be mentioned.

On Seco Creek, one and one-half miles above Rothe Ranch, about four miles north of D'Hanis, the most southern exposure of the Austin formation on Seco Creek is found. From this point the Austin chalk occupies the creek bed and the adjacent bluffs for approximately one and one-half miles to the north. At this locality it is chiefly a chalky limestone carrying the typical Austin fauna. Some of the bluffs reach a height of about 40 feet. The chalky limestone is moderately massive, evenly bedded, and has well defined joint planes. There are few soft ledges, and the general lithologic uniformity of the strata results in an almost vertical bluff. The range in vertical section on Seco Creek is about 200 feet, the remaining 150 feet being concealed either from faulting below the surface or from being covered by alluvium. The *Gryphea aucella* horizon was not found and it is quite probable that the vertical section does not extend to that elevation in the Austin formation. To the west and to the east of Seco Creek the Austin formation is commonly found in the uplands, but no good exposures were located.

On Hondo River, a good exposure is located three and one-half miles north of Hondo. At this point, however, the Austin formation, though totaling slightly more than 275 feet in vertical section, does not have a very large areal extent. Faulting both parallel and at right angles to the general strike of the formation has produced some local steep dips.

At the above locality on the Hondo River, the contact of the Austin chalk with the Eagleford formation is found. It is difficult to make the distinction upon lithologic data, but the fauna of the two formations readily identifies them. From the base of the Austin formation practically throughout the exposed section there are glauconitic layers. Most of the glauconite, however, is confined to the lower part of the formation.

Though the Austin chalk is present in small outcrops for some ten miles east of Hondo River, there are no good exposures. In an area beginning just west of Medina River, and continuing for six miles to the west, block faulting has eliminated the entire Austin as well as the Eagleford and Anacacho formations.

Beginning approximately at the Medina River and extending to the Bexar-Medina County line in the vicinity of Cliff, there are excellent exposures of the Austin formation. At the road crossing of the Medina River, one-half mile west of Red Wing and one mile south of the diversion dam, glauconitic Austin chalk of the lower part of the formation is exposed on the east bank of the river. At this locality it is highly glauconitic and contains a number of *Inocerami* and a few *Gryphea aucella.* To the north, the Austin formation is faulted against the Edwards formation and on the east it has contact with the same formation. In a small creek which crosses the road at Red Wing, the *Gryphea aucella* horizon outcrops in the creek bed at the east side of the road. Here it is probably the most highly glauconitic and, as in the remainder of the county, is a shell conglomerate of *Gryphea aucella.* Some 15 feet higher than the *Gryphea aucella* horizon, there is a horizon carrying much limonite which is exposed in the road cut 300 feet from the creek. Some of the fossils apparently are dwarfed by the pyritic conditions and in many instances the limonite has entirely replaced the fossils. There is a small *Gryphea* present which greatly resembles *Exogyra arietina,* of the Del Rio formation, but upon close examination the specimens are distinctly different.

At Cliff, on the San Geronimo Creek, there is an excellent exposure of the fossiliferous Austin formation. It has a dip of 3° S. 80° E. The bluff is 70 feet high and nearly vertical. Though the formation is slightly nodular at the basal part of the exposure, it is quite uniformly a chalky marl. The bedding planes are approximately two to three feet apart and the jointing is very well defined. Though it could not be accurately placed in the Austin section, the exposure at Cliff probably belongs quite high in the formation—very probably above the *Gryphea aucella* horizon. No glauconite was found at this exposure.

The Upson Clay

Though the Upson clay is not exposed at the surface in Medina County, it is quite probably correctly identified as present in the McClure test, three miles southeast of Dunlay. Here a soft yellow clay, unlike the Anacacho limestone or the Austin chalk, underlies the Anacacho limestone. The yellow marls which Vaughan[6] places in the bottom of the Anacacho probably are the eastern equivalent of the Upson clay. It is quite possible that the Upson clay as such extends as far east as the Anacacho limestone can be identified, for the basal part of the clay passes under the Anacacho limestone at the western edge of the Anacacho Mountains, and the Anacacho is at least a partial eastern equivalent of the upper part of the Upson clay.

The Anacacho Formation

Since the first definition of the Anacacho[7] and Escondido formations there has been considerable variance in opinion as to the line of demarcation between the two formations and their correlation with the Taylor and Navarro formations to the east. The principal basis for confusion lies in the inadequacy of the information contained in the original descriptions. From these descriptions it is impossible to determine exactly what strata were included in each of the formations. To eliminate such confusion and establish a demarcation, the original localities should be visited and the sections described in detail. If the original descriptions be found to include the proper strata for the respective formations, the line of differentiation should be placed as near as can be determined to the original position. Should the line of contact of the formations fail to coincide with the lithologic and paleontologic break, the contact should be adjusted to meet such requirements.

Though it has been impossible to redescribe the type localities and trace such a line of contact east to Medina County, the method outlined has been employed in establishing the contact between the Anacacho and the Escondido formations in Medina County. Changing conditions influencing the nature of sedimentation, along the old shore line, have resulted in considerable lateral variation within the

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[6]Vaughan, T. W., Uvalde Folio. U. S. Geol. Surv.

[7]18th Ann. Rept., U. S. Geol. Surv., Pt. II, p. 240.

Anacacho limestone. This change in the type of sediments deposited contemporaneously is evident in Medina County and the same conditions are reported to exist on even a greater scale in the area to the west.

Under such near-shore deposition, lateral changes are to be expected. However, if such a rate of variation be determined there should be little trouble in identifying contemporaneous deposits, even though they are lithologically dissimilar. With the added paleontologic data the problem is somewhat simplified.

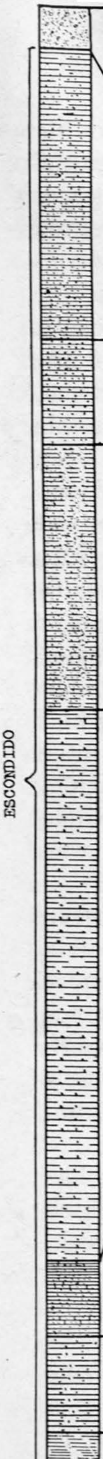
The base of the Anacacho limestone is not exposed at the surface in Medina County. Since the area of its surface outcrop across the entire county lies in a zone of extensive faulting, either the entire Anacacho limestone is faulted below the surface, or smaller faults conceal the base of the formation.

Between the areas of best exposures the Uvalde and Leona formations cover the contacts so that definite information is not available.

From the log of the McClure well, three miles southeast of Dunlay, there is some evidence that the Upson clay, though quite thin, extends under the Anacacho limestone and above the Austin chalk, as far as Dunlay. The Upson clay, which has an extensive development west of the Anacacho Mountains, in Kinney County, and which is in part the equivalent of the basal Anacacho, thins out against the western edge of the Anacacho Mountains, and passing under them continues to the east between the Austin and the Anacacho formations. The Upson formation has not been found at the surface in Medina County.

The best exposures and the most complete section of the Anacacho limestone are found on Seco Creek, from two to four and one-half miles north of D'Hanis. At this locality the lithology of the formation is very similar throughout the entire section. In the lower part, however, the limestone contains more fossils which can be identified. These fossils, though present in the upper part, are so fragmentary that they can not be recognized specifically.

Approximately 100 feet of the upper Anacacho limestone are exposed in Medina County. The formation is remark-



RECENT GRAVEL AND SOIL. GRAVEL CHIEFLY COMPOSED OF LIMESTONE FRAGMENTS OF THE COMANCHEAN MIXED WITH SOME PIECES OF THE MORE RESISTANT FORMATIONS OF THE UPPER CRETACEOUS. SOIL COMPOSED PRINCIPALLY OF MATERIAL FROM LESS RESISTANT UPPER CRETACEOUS FORMATIONS

ARENACEOUS CLAY. PREDOMINANTLY YELLOW BUT VARIEGATED AT THE BASE. A FEW POORLY PRESERVED PECTENS AND SOME UNIDENTIFIABLE PELECYPODS. THIS HORIZON CONTAINS NOTICEABLY LESS SAND THAN THE SHALY CLAY IMMEDIATELY BELOW. THIS HORIZON SUPPLIES THE CLAY FOR THE BRICK YARDS AT D'HANIS. ESCONDIDO.

VARIEGATED SHALY CLAY, CHIEFLY RED, BLUE, YELLOW, AND VERMILLION. NO FOSSILS OBTAINED. ESCONDIDO.

VERY ARENACEOUS MARL CONTAINING NUMEROUS GRYPHEA VESICULARIS OF THE MASSIVE VARIETY. NO SPECIMENS OF THE SMALLER VARIETY WERE OBSERVED. NUMEROUS ANANCHYTES TEXANA ASSCIATED WITH A FEW SMALL PECTENS AND A NUMBER OF LARGE LOOSELY COILED TURRILITES. THE MARL IN PLACES CONTAINS SO MUCH ARENACEOUS MATERIAL THAT IT IS PRACTICALLY A TRUE SANDSTONE. IT WAS FROM THIS LOCALITY THAT CRAGIN'S TYPE FOSSILS OF ANANCHYTES TEXANA WERE OBTAINED. ESCONDIDO.

EXOGYRA PONDEROSA HORIZON. SOFT YELLOW CLAY BECOMING MORE ARENACEOUS TOWARD THE TOP OF THE HORIZON. EXOGYRA PONDEROSA IN ABUNDANCE. NO EXOGYRA COSTATA COULD BE FOUND, THOUGH IT IS COMMON IN THIS HORIZON, ESPECIALLY NEAR THE TOP, EAST OF THE MEDINA RIVER. THIS SPECIES OF EXOGYRA PONDEROSA IS VERY DISTINCT FROM THE SMALLER AND MORE HIGHLY ARCHED SPECIES OF THE AUSTIN CHALK. IN THE TOP OF THE HORIZON ARE A NUMBER OF LARGE PACHYDISCUS. THE PACHYDISCUS HORIZON IS CORRELATED WITH THE SAME HORIZON WHICH OCCURS ABOVE THE EXOGYRA PONDEROSA HORIZON ON THE HONDO RIVER. ESCONDIDO.

ARENACEOUS, YELLOW, SOFT CLAYS. THE CALCAREOUS MATTER IS PRESENT IN CONSIDERABLE QUANTITIES. IT RARELY FORMS MORE THAN A VERY THIN LIMESTONE BAND. PYRINA AND VENERICARDIA SP. WERE THE ONLY FOSSILS COLLECTED, WITH THE EXCEPTION OF A FEW GRYPHEA VESICULARIS, WHICH EVIDENTLY IS APPROXIMATELY THE HIGHEST OCCURRRENCE OF THE SMALL VARIETY OF GRYPHEA VESICULARIS. NO SPECIMENS OF THE MASSIVE VARIETY WERE OBSERVED. ESCONDIDO.

GRYPHEA VESICULARIS HORIZON. ARENACEOUS, GLAUCONITIC MARL. THE ENTIRE HORIZON IS A SHELL CONGLOMERATE OF GRYPHEA VESICULARIS TESTS CONTAINING SOME SAND AND CONSIDERABLE GLAUCONITE AND CEMENTED TOGETHER WITH CALCIUM CARBONATE. NO FOSSILS EXCEPT GRYPHEA VESICULARIS WERE FOUND IN THIS HORIZON. ESCONDIDO.

ARENACEOUS MARL CONTAINING SOME CALCIUM CARBONATE AND SOME CLAY. PECTEN SP. WERE THE ONLY FOSSILS IDENTIFIED. ESCONDIDO.

ANACACHO LIMESTONE - THE ANACACHO ASPHALT ROCK. AN ORGANIC FRAGMENTAL LIMESTONE COMPOSED CHIEFLY OF THE COMMINUTED TESTS OF SMALL ECHINOIDS LIKE PYRINA. GENERALLY ASPHALTIC. A FEW BACULITES WERE COLLECTED. THE FORMATION IS EVIDENTLY A SUBMERGED BAR OR BEACH.

Figure 3

Section of the Anacacho and Escondido formations on Seco Creek, two to three miles north of D'Hanis, Medina County. Scale, 1 inch=25 feet.

ably uniform in texture in the western part of the county and consists of a heavily-bedded, yellow-brown, organic-fragmental limestone. When locally asphaltic the rock is dark brown or black in color. Under all conditions observed it weathers lighter on exposed surfaces. The limestone consists of the fragments of various organisms both megascopic and microscopic. From the fragments observed two genera of echinoids apparently afforded the greater part of the organic material. Fragments of the large echinoderm, *Ananchytes texana* Cragin, and numerous small echinoids resembling *Pyrina* were collected. In addition there were a few corals, small pelecypods and a number of *Baculites*. The comminuted tests of these various organisms, mixed with a coarse sand, are cemented by calcium carbonate probably to a great extent derived from the calcareous matter in the tests of the organisms. Throughout, the formation is uniformly a beach or near-shore sedimentation. The presence of the coarse sand, the remains of organic life which is confined to shallow water and near-shore conditions, and the presence of cross-bedding show the material to have been deposited rapidly and near to the land. The position, thickness and extent of the Anacacho limestone as a whole indicate a near-shore type of deposit. The formation was probably an old sand bar, which later was submerged.

The cavities of the limestone and the interstices between the shell fragments and the coarse sand grains are frequently filled with asphalt. Such asphalt seeps are more common along small faults. A great part of the surface area of the Anacacho limestone shows very little asphalt, but nearly all the water wells in the country which have penetrated this formation have reported shows of heavy oil from this horizon.

The resistance to erosion of the Anacacho limestone has caused it to remain as the prominent relief in the area which it occupies. Both to the west and to the east of Seco Creek, it forms the hills which stand from 75 to 100 feet above the surrounding country. Throughout the entire area its physical properties are very similar.

On and to the east of Hondo River the Anacacho limestone is practically faulted out of sight. With the exception of a small area exposed on the Hondo River, two and one-half miles north of Hondo, there are no further outcrops of the formation west of Medina River, until the Hondo River is reached.

Both in Seco Creek and in the Hondo River where it is possible to make any extended observations, the Anacacho limestone is considerably faulted. Accompanying such faults are dips varying from 2° to 6° north and west of north. A quarter or a half mile above the Rothe Ranch the Anacacho limestone is well exposed in the west bank of Seco Creek. At this locality the dip varies from 4° to 6° slightly west of north. In all probability there are at least two small faults within the area of the Anacacho outcrop, one three-fourths of a mile south of the Rothe Ranch house and the other a half mile north of the ranch house. At the most southern exposure of the Anacacho on Seco Creek there is a small fault, which is probably close to the end of the extensive faulting which has continued in this zone from east to west across the county. The extension of the Anacacho down Seco Creek is to some extent influenced by the small local faults just referred to, which with a downthrow to the south, have afforded gentle north dips which have brought the overlying Escondido below its normal position at and immediately south of Rothe's Ranch. The greater part of the areal exposure of the Anacacho at this locality on Seco Creek is influenced by the drainage which has cut away the Anacacho immediately to the east and in the stream bed, while the Escondido hills to the west have remained.

The narrowing of the surface exposure of the Anacacho from one and one-half miles to one-eighth mile in width, in a horizontal distance of less than a quarter of a mile, indicates in addition to the main fault which places the Austin against the Escondido, a second fault at approximately right angles to the first, which has practically eliminated the surface exposures of the Anacacho limestone. At this locality on the Hondo River, two and one-half to three miles north of Hondo, the main fault roughly paralleling the Balcones has given contact between the *Gryphea aucella* horizon of the Upper Middle Austin chalk and the *Gryphea vesicularis* horizon 10 feet above the base of the Escondido. In the bed of Hondo River the Anacacho limestone is exposed, while the banks are composed of basal Escondido material. A slight tilting of the block to the southwest, together with the drainage from the east, has afforded a little surface Anacacho east of the Hondo River, and a less amount immediately to the west of the river. Were it not for the drainage at this point being sufficiently developed to reach down to the Anacacho, there would be no surface exposures of the Anacacho limestone east of the fault which is half a mile west of Hondo River, and west of Medina River.

Immediately to the south of the second zone of faulting and east of Medina River, the structure which Sellards[8] has described as plunging south of west in Bexar County, enters Medina County. The central part of the structure is in the vicinity of Loma Alta. As indicated on the map, this structure in Medina County consists of a core of Austin chalk, around which in ascending order to the southwest are the Anacacho and Escondido formations. All of these formations plunge southwest. West of the Medina River the structure flattens out and reverts to the normal areal position of the formations, with a general dip to the southeast. Around the Austin chalk core of the structure and indicated topographically by a ridge of hills some 75 to 100 feet higher than the surrounding country, is a moderately narrow band of the Anacacho limestone. In localities the Anacacho in this region is identical with that in the western part of the county, but on the whole there is much lateral variation in this formation across the county. Without doubt there is as much lateral change in the Anacacho limestone across Medina County as there is in the Eocene-Midway. The point of most radical change of both the Midway and the Anacacho is on a line five to six miles west of the Medina-Bexar county line, approximately north and south and roughly at right angles to the old shore lines.

Though some of the Anacacho east of Medina River is lithologically identical with the same formation in the west-

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[8]Sellards, E. H., Geology and Mineral Resources of Bexar County. Univ. Texas Bull. 1932.

ern part of the county, the greater part is much finer and more arenaceous. As a rule it is more universally asphaltic, especially in the finer material.

The best outcrop of the finer material of the Anacacho is in the bed of San Geronimo Creek at the bridge one mile south of Rio Medina. At this locality the Medina River has cut through the Escondido, which is seen in the creek banks on the east side of the creek just north of the road from Rio Medina to Loma Alta. The Anacacho limestone occupies the creek bed from just below the Rio Medina-Castroville road bridge, one mile south of Rio Medina to just above the San Geronimo Creek crossing on the Rio Medina-Loma Alta road. The material is for the most part a medium fine, organic-fragmental limestone, very fossiliferous and impregnated with asphalt. The number of pelecypods is much greater than that found in the western part of the county. The finer material, though affording more pelecypods, contains less calcite from the tests of echinoids. The coarser material has less bitumen, fewer pelecypod remains, but many more fragments of echinoid tests. At this locality the dip is from 1° to 2° southwest. Toward the east, which is toward the center of the structure, the dip increases in amount to the southwest. About ten feet of the material are exposed at this locality and it is cross-bedded in places.

Since the material which underlies the Anacacho asphalt rock, whether it be the eastward extension of the Upson clay or the Austin chalk, is so radically different both lithologically and paleontologically that there is no difficulty in establishing the base of the Anacacho. The material below is a clay or a chalk which is easily distinguished from the organic limestone containing asphalt, of which the Anacacho formation is composed. Though only some 100 feet in actual section of the Anacacho asphalt-bearing limestone have been found in Medina County, measurements by Vaughan in Uvalde County to the west, and the information afforded by well logs in Medina County, indicate that close to 200 feet of the fragmental limestone are present in Medina County.

In the Anacacho formation of Medina County there are included, then, approximately 200 feet of organic fragmental limestone carrying asphalt in nearly all localities. In the upper 100 feet of the section as exposed in the county, there is no other material; and from the data obtained from well logs the entire thickness of this formation is composed of the same organic limestone. The top of the Anacacho formation in Medina County has been established at the top of the organic-fragmental limestone carrying the asphalt. At this point in the column there is a decided break, both lithologic and faunal. Resting immediately upon the Anacacho limestone wherever exposed across the county is a glauconitic, organic marl, neither physically nor biologically resembling the underlying limestone. The marl is highly glauconitic, soft, arenaceous, contains no asphalt and carries a fauna entirely distinct from the Anacacho limestone.

The basal five feet of the glauconitic marl which is the base of the Escondido formation is poorly fossiliferous. A few *Pectens* and *Venericardia* are the only specimens that were obtained. Lying immediately on this poorly fossiliferous horizon is an organic conglomerate composed of masses of *Gryphea vesicularis*. This horizon has been positively identified entirely across the county. The organic fragmental limestone containing asphalt and lying five to ten feet below the *Gryphea vesicularis* horizon of the Escondido, is placed at the top of the Anacacho formation in Medina County.

The Escondido Formation

Between the Anacacho limestone of the Upper Cretaceous and the Elstone glauconitic limestone of Eocene-Midway age are approximately 700 feet of arenaceous clays and thin-bedded limestones of the Escondido, which is the uppermost Cretaceous formation in Medina County.

The base of this formation is a poorly fossiliferous, yellow, glauconitic marl resting upon the organic-fragmental limestone of the Anacacho. The contact between the two formations lies five to ten feet below the *Gryphea vesicularis* horizon of the Escondido. There is a decided break both in the lithology and in the paleontology of these two formations. No glauconite is found in the Anacacho and no asphalt has been seen in the Escondido. The organic limestone, composed of the comminuted tests of megascopic and microscopic organisms, chiefly of echinoids, evinces an entirely different type of conditions under which the sedimentation of the Anacacho and the Escondido occurred. The faunal hiatus is as abrupt as the physical break. Of the millions of echinoids which existed during Anacacho times and whose remains to a great extent compose the Anacacho limestone, only a few continued in Escondido times. With the inception of the new lithological cycle, similarly a new biologic cycle began. A few of the original genera survived the environmental change, but the majority became extinct and a new fauna supplanted the old. The great decrease both in the number of genera which survived the change and the amount of animal life representing these genera, indicates as great a paleontologic as a lithologic break between the Anacacho and the Escondido formations.

Similarly, in ascending the geologic section of the Escondido, there is a gradual lithologic change and a corresponding biologic adaptation. From the soft, yellow, arenaceous, glauconitic marls of the basal Escondido, which contain no limestones, there is a rapid increase in the amount of arenaceous material throughout the basal 100 feet, reaching a maximum in the *Ananchytes texana* horizon. From this horizon to the top of the formation there is a decrease in the amount of arenaceous material and a corresponding increase in the amount of calcareous matter. In the basal 200 feet of the Escondido there are not known to be any true limestones, while in the upper 100 feet of the formation about 70 per cent are hard, yellow, fine-grained, slightly arenaceous limestones. From base to top throughout the Escondido, there is clear evidence of sedimentation occurring in deeper water. The break between the Anacacho limestone and the Escondido marks a break between beach or sand bar conditions and deposition which, though near shore, is characteristic of much deeper water. The decrease in amount of arenaceous material and the increase in calcareous matter show that the waters of late Escondido times in which the uppermost Cretaceous sedimentation in Medina County occurred, were much deeper than the waters of early Escondido times.

In the basal 150 feet and the uppermost 100 feet of the Escondido, definite paleontologic horizons have been determined which have been identified wherever exposed in all parts of the county. In the middle 500 feet of the Escondido no key horizons could be established. In general, the fossils *Gryphea vesicularis,* and *Exogyra ponderosa,* and, in the eastern part of the county, *Ananchytes texana* and *Exogyra costata* characterize the lower 150 feet of the Escondido while *Sphenodiscus pleurisepta* and *Ostrea cortex* are confined in the majority of cases to the upper 100 feet of the Escondido formation entirely across Medina County.

The best outcrop of the basal Escondido is found on Seco Creek between Rothe Ranch, three and one-fourth miles north of D'Hanis, and the town of D'Hanis. At the most northern extension of the Escondido, the strata are younger than those at the crossing of Seco Creek two miles north of D'Hanis. This abnormal condition is caused by some small faults, with a downthrow to the south, which have placed the Anacacho below the bottom of the creek at Rothe Ranch. At the crossing two miles north of D'Hanis the Anacacho occupies the creek bed but the dip averaging approximately 2° north and west of north has placed the base of the Escondido below the water level at Rothe Ranch. The basal five feet of this section are composed of a soft, yellow, glauconitic marl containing few fossils. A small *Pecten,* a small *Venericardia* and an echinoderm resembling *Pyrina* are the only fossils that were obtained. Overlying the basal five feet of the Escondido section are 10 feet of yellow, glauconitic, shell conglomerate, practically composed of the tests of *Gryphea vesicularis,* in good state of preservation. In this *Gryphea vesicularis* horizon on Seco Creek no other fossils were found. Because of its individuality and the restricted range of the fossils this horizon is easily identified at any point of its outcrop in the county. As will be discussed later, this horizon was also identified at one locality in Bexar County. In the *Gryphea vesicularis* horizon on Seco Creek, the specimens are practically confined to a single species, while in the eastern part of Medina County, and in western Bexar County in addition, there is a massive variety of *Gryphea vesicularis* which may be a varietal modification of the species *vesicularis* or upon closer examination may prove to be sufficiently different from the smaller species to warrant a new specific name. At present, however, it will be referred to as the massive variety of *Gryphea vesicularis.* A few massive *G. vesicularis* were found in the *Ananchytes texana* horizon near Rothe Ranch, but practically none in the *G. vesicularis* horizon in the western part of Medina County. The two basal members of the Escondido just described, from Seco Creek, are exposed at the road crossing of Seco Creek two miles north of D'Hanis. At this place the Anacacho limestone occupies the creek bed while the banks are composed of the basal Escondido.

Above the *Gryphea vesicularis* horizon are eight feet of poorly fossiliferous, yellow, arenaceous clay. The argillaceous material is in excess of the calcareous matter. A small echinoderm similar to *Pyrina* and a few small *Venericardia* are the only fossils that were obtained.

The *Exogyra ponderosa* horizon of the Escondido lies immediately above the poorly fossiliferous marl just described. It is a soft yellow clay, gradually becoming more arenaceous toward the top. No limestones were found in this horizon. Throughout the entire horizon, the large variety of *Exogyra ponderosa* is very abundant and perfect specimens are readily obtained. This variety is markedly different from the species of *Exogyra ponderosa* characteristic of the Austin chalk. Böse[9] has differentiated two species of *Exogyra;* one from the Austin chalk and the other from the Taylor marl. A similar differentiation is here made between the species characteristic of the Austin chalk and the one from the basal Escondido. Without doubt the specimens obtained from the Austin chalk in Medina County are identical with the ones Böse described from the Austin

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[9] Böse, Emil, On a New Exogyra from the Del Rio Clay and some Observations on the Evolution of Exogyra in the Texas Cretaceous. Univ. Texas Bull. 1902.

chalk, and also the species characteristic of the basal Escondido of Medina County is identical with the species described by him from the Taylor formation. There is sufficient dissimilarity so that if no other fossils are present the formations can be identified by these two fossils.

There are approximately 60 feet of the *Exogyra ponderosa* horizon in Medina County and *Exogyra ponderosa* so far as known is confined to this horizon. The base of the horizon is found 22 feet above the Anacacho limestone in the west bank of Seco Creek two miles north of D'Hanis. It is from the upper part of this horizon and from the material next higher in the section that the clays of the two brick companies at D'Hanis are obtained.

The uppermost 15 feet of the *Exogyra ponderosa* horizon contain a number of large ammonites of the genus *Pachydiscus*. At the Louis Rudinger Ranch, one and one-fourth miles southwest of the crossing of the Seco two miles north of D'Hanis, a number of *Pachydisci* were found associated with the uppermost *Exogyra ponderosa*. At no other place in the county were these ammonites found; and, being associated with the *E. ponderosa* and exposed only in one locality, it was not possible to determine their horizon accurately. They are known, however, to occupy the uppermost 15 feet of the *E. ponderosa* horizon. If they range higher in the section it is not known.

The *Exogyra ponderosa* horizon becomes more arenaceous toward the top and passes into 30 feet of medium hard, very arenaceous brown marl, carrying numerous *Ananchytes texana* Cragin. The chief outcrop of this horizon is in the bed of Seco Creek at Rothe Ranch and at this outcrop the dip is S. 70° W.

The fauna of the sandy marl is quite varied. The chief fossil, however, is *Ananchytes texana* Cragin. The horizon is appropriately named the *Ananchytes texana* horizon, for it was from this locality that the type specimens described by Cragin[10] were collected and *Ananchytes texana* is not known to range outside this arenaceous marl. Asso-

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[10]Cragin, F. W., A Contribution to the Invertebrate Paleontology of the Texas Cretaceous. Geol. Surv. Texas, 4th Ann. Rept., 1892.

ciated with *Ananchytes texana* was found the massive variety of *Gryphea vesicularis*, a few big, loosely coiled *Turrilites*, numerous medium-sized *Inocerami*, and *Rudistids*.

Two sets of joints are well developed in the marl at the above locality. They are at right angles to each other and at intervals of from 40 to 50 feet. One set of joints is approximately coincident with the dip of the marl and the other about at right angles to the first set.

The clays of the two brick yards at D'Hanis come above the *Ananchytes texana* horizon. The clays are at least 125 feet thick and contain practically no limestone ledges. In both pits much selenite was found and at the D'Hanis company pit there are red bands in the clays which carry an abundance of shark's teeth. An occasional *Pachydiscus* is found in the clay beds and many small oysters, with a few *Turrilites*.

On account of the Uvalde and Leona formations which, with the exception of isolated outcrops that are too small and widely separated to give a continuous section, conceal the Escondido south of D'Hanis, no more definite knowledge of the middle 500 feet of the Escondido can be had than that it is known to be composed of alternating arenaceous clays and hard, yellow-brown limestones. The clay layers are about one to two feet thick and the limestone from one to two and one-half feet thick. The limestones are more in abundance and there are fewer clay layers encountered as the top of the Escondido is reached. The limestone also becomes less arenaceous, a deeper yellow or light brown color, and considerably harder. At the Cretaceous-Eocene contact eight and one-half miles southwest of D'Hanis the uppermost 15 feet of the Escondido are exposed. This part of the formation is composed chiefly of hard, gray-yellow, fine-grained sandstones with numerous *Ostrea cortex*. The clay is practically absent. This outcrop belongs in the top of the *Ostrea cortex* horizon. The strata lower in the section are covered and the *Sphenodiscus* horizon which underlies the *Ostrea cortex* horizon is not exposed.

West of Seco Creek and between Seco Creek and the Hondo River the Escondido is practically covered by the

Uvalde and Leona formations. Although small outcrops of the Escondido occur at short intervals, the exposures are not of sufficient extent for vertical sections. They indicate, however, that the Escondido underlies the entire area at a very shallow depth.

On Hondo River two and one-half miles north of Hondo, the second largest exposure of Escondido is found under conditions similar to those on Seco Creek. Lithologically and paleontologically the section is practically identical with that in Seco Creek two miles north of D'Hanis.

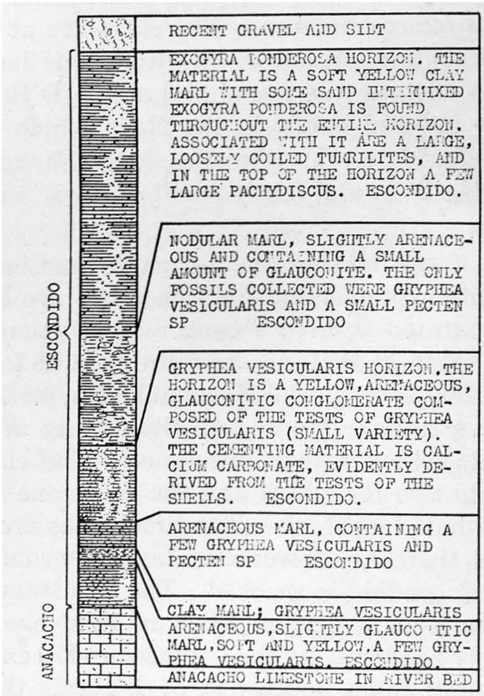


Figure 4

Section of the Anacacho and Escondido formations on Hondo River, two and a half miles north of Hondo, Medina County. Scale, 1 inch = 20 feet.

Faulting at this locality on Hondo River approximately parallel to, and at right angles to the main fault of the Balcones system has practically eliminated the surface exposures of the Anacacho limestone and has dropped the base of the Escondido to the upper middle of the Austin chalk. The *Gryphea vesicularis* horizon of the Escondido is faulted practically to the same level as the *Gryphea aucella* horizon of the Austin chalk. This faulting places the Anacacho limestone in the river bed for about one-eighth of a mile, but the banks of the river are of the basal Escondido.

The basal nine feet of the Escondido directly overlying the Anacacho limestone are the equivalent of the five feet underlying the *Gryphea vesicularis* horizon on Seco Creek. The material is a glauconitic arenaceous marl, slightly fossiliferous, containing a few *Gryphea vesicularis* and *Pecten* sp. Immediately overlying the poorly fossiliferous horizon are eight feet of a yellow glauconitic marl, which is practically an organic conglomerate of *Gryphea vesicularis* tests. This horizon is readily identified as the *Gryphea vesicularis* horizon, described from Seco Creek. In thickness as well as physical and biologic characters it is the exact equivalent of the same horizon on Seco Creek.

Between the *Gryphea vesicularis* horizon and the *Exogyra ponderosa* horizon, there are 12 feet of nodular, slightly arenaceous and glauconitic marl containing a few *Pectens* and an occasional *Gryphea vesicularis.* This material undoubtedly corresponds to the eight feet of soft yellow marl overlying the *Gryphea vesicularis* horizon on Seco Creek.

The uppermost Escondido of the section on Hondo River consists of 40 feet of the lower *Exogyra ponderosa* horizon. The remaining 20 feet of the complete horizon which is exposed on Seco Creek have been eroded at this locality. The range of *Pachydiscus* on Seco Creek is considered to be in the upper 20 feet of the *Exogyra ponderosa* horizon, and on Hondo River a single specimen of this ammonite was found on the top of the section. This would seem to indicate that the thickness of the *Exogyra ponderosa* horizon on the Hondo River is practically the same as the thickness of the same horizon on Seco Creek, and that the top of the section on Hondo River is at the lower limit of the vertical range of *Pachydiscus.* According to these data about 15 feet of the top of the *Exogyra ponderosa* horizon have been eroded from this locality on Hondo River.

Numerous exposures of Escondido are found over the entire area between Hondo River and Medina River, but in comparison with the two main exposures just described they are unimportant in affording detailed information for the general Escondido section. They are valuable, however, in determining the area in which the Escondido immediately underlies Quaternary and Recent deposits.

On San Geronimo Creek in the bluff on the east side of the creek, just north of the Rio Medina-Loma Alta road, the Escondido occupies the bank of the creek and the adjacent hill, giving a section of some 60 feet. The greater part of the section is covered and though at intervals of from two to three feet the Escondido was found in place on the section, the exposures were not sufficiently large for detailed observations. In the base of the hill the *Gryphea vesicularis* horizon was identified and near the top of the same hill the *Exogyra ponderosa* horizon was found. East toward Loma Alta the Anacacho, surrounding the Austin core of the structure at this locality, is encountered, as the highlands.

On the Medina River at the private road crossing of Louis Bendeler, about four and one-half miles west of north from Castroville, the *Gryphea vesicularis* horizon is found in a bluff on the west bank of the river. Some 15 feet of the Escondido, coming in the general section below the *Gryphea vesicularis* horizon, were measured. Associated with the *Gryphea vesicularis,* which practically composes the material of the horizon, are numerous *Exogyra costata. Exogyra costata* has not been found west of Medina River though there are excellent exposures of the horizon which contains this fossil east of Medina River. The Medina River seems to be about the western limit of *Exogyra costata* in Medina County. Though excellent exposures of the proper horizon were examined in the western part of the county and *Exogyra ponderosa* were collected, no evidence of *Exogyra costata* was found. Singularly, no *Ananchytes texana* was found east of Seco Creek and none has been reported from any locality east of this area. *Pachydiscus* is also practically confined to the western half of Medina County.

The escarpment on either side of the Loma Alta-Cliff road from one to three miles south of Cliff, is composed of basal Escondido. *Gryphea vesicularis* was positively identified along the entire bluff throughout the area. This outcrop is identical with the one on the Castroville-San Antonio road, one and one-half miles east of the Medina-Bexar county line. Both of these outcrops contain masses of the large variety of *Gryphea vesicularis* which has a hinge width of from six to eight inches. Associated with the massive variety are numerous specimens of the smaller variety. At this section also *Exogyra costata* is found in abundance, associated with both *Gryphea vesicularis* and *Exogyra ponderosa*. The bluff affords 70 feet of vertical section in localities and it is chiefly composed of soft yellow clay with interbedded limestone lenses. The clays carry the fossil remains.

The presence of the limestones in the base of the Escondido east of the Medina River and the almost total absence of them in the western part of the county, as well as the paleontologic variance, indicate considerable lateral variation in the Escondido. There is also very little glauconite in the Escondido east of Medina River.

In the bed of a small creek crossing the road two miles west of north from Castroville, about 25 feet of calcareous Escondido are found. The dip is $1\frac{1}{2}°$ S. 30° W. The individual beds average about four feet in thickness. From the physical and paleontologic characters of the outcrop, this horizon is correlated with the upper part of the section exposed at Rothe Ranch in the western part of Medina County. The *Inoceramus* and a small *Pecten* characteristic of the horizon at Rothe Ranch, just above the *Ananchytes* horizon, are both present at this outcrop. This horizon is about 50 feet above the *Gryphea vesicularis* horizon which in general lies some five to ten feet above the Anacacho limestone.

In the bed of the Medina River at Castroville there are 25 feet of arenaceous shale similar in texture to the upper part of the section at Rothe Ranch. In the section it is next above the exposure just described as two miles west of north from Castroville. The fossils readily identify it as the

Escondido. *Inocerami*, *Baculites*, the massive variety of *Gryphea vesicularis*, *Exogyra ponderosa*, *Exogyra costata* and undetermined *Pectens* and gastropods were collected. The dip is 1½° S. 50° W.

South of Castroville the outcrops are quite numerous but are so small that little detailed information could be obtained. Over this area, however, the Escondido is composed for the most part of alternating arenaceous shales and arenaceous clays with interbedded hard brown limestone ledges from one to three feet in thickness. In the vicinity of Noonan the hard brown-yellow limestones compose the greater part of the section. At this horizon in the section just below the Cretaceous-Eocene contact, the limestones are full of fragments of *Ostrea cortex*, which correlates the outcrop with the top of the Cretaceous section at Rock Crossing on the Hondo River and the uppermost Escondido in western Medina County. At Rock Crossing on the Hondo River, one and one-fourth miles north of the Elstone bridge, 15 feet of the uppermost Cretaceous strata are well exposed in the river bed. The section contains hard, brown-yellow limestones with thin clay shale partings. The limestones are hard, blue or yellow-brown on freshly broken surfaces, and weather darker. Most of the fossils are found in the limestones. *Sphenodiscus pleurisepta* and *Ostrea cortex* are the principal fossils. The *Sphenodiscus* horizon here exposed is considered the uppermost part of the *Sphenodiscus* horizon at its contact with the *Ostrea cortex* horizon, which is the uppermost Escondido in Medina County.

Associated with the *Sphenodiscus pleurisepta* were *Nautilus*, *Cardium* and *Anomia* sp. The *Ostrea cortex* horizon contained undetermined gastropods, a *Nucula*, *Turritella* and other *Ostrea* sp. different from *Ostrea cortex*. The dip of the Escondido is 2° northwest. The presence of this Escondido inlier in the Eocene area and the outliers of Eocene in the Cretaceous area at this locality indicate a disturbance which has elevated the strata at Rock Crossing, thus exposing the Escondido at the crossing and concealing it under the Eocene to the north. The northwest dip of the Cretaceous strata at Rock Crossing indicates probably a fold or possibly a fault to the north of the Escondido inlier.

Lateral Variation in the Escondido

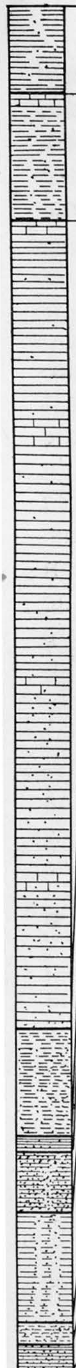
In the basal part of the Escondido in Medina County there is considerable change both in lithology and paleontology between the deposits in the eastern and western parts of the county. East of the Hondo River the basal Escondido contains much more calcareous matter and relatively less arenaceous material than is found in the western part of the county. The strata themselves upon examination immediately determine this and the nature of the topography in the eastern part of the county at once reveals an increased amount of calcium carbonate. To some extent, however, the topography is determined by the drainage, but this feature is not wholly accountable for the change. The glauconite which is very abundant in the basal Escondido in western Medina County is much less evident in the material east of Hondo River.

The change to more typical beach conditions toward the west with the deposition of the Anacacho limestone, which probably begins as such in western Bexar County, and the continuation of modifications of these conditions into Escondido times, is possibly the explanation of the lithologic and paleontologic transition. In this lateral variation there is a paleontologic change which corresponds to the physical transition. The oyster *Exogyra costata,* which east of Medina River is found associated with *Gryphea vesicularis* and *Exogyra ponderosa,* in their respective horizons, has not been found west of the Medina River in Medina County and is not recorded by Vaughan from Uvalde County.

Although good exposures of the proper horizons are found on Hondo River and Seco Creek, not a single specimen of *Exogyra costata* has been found at either of these localities. In the eastern part of Medina County, *Exogyra costata* probably is almost as abundant as *Gryphea vesicularis,* and much more abundant than *Exogyra ponderosa.* The massive variety of *Gryphea vesicularis* is also much less common in the western part of the county than in the eastern part. Perhaps as radical a paleontologic break as the disappearance of *Exogyra costata* west of Medina River is made by the inception of *Ananchytes* in the western part of the county. So far as known, not a single specimen of this echinoderm has been found east of Hondo River. At the type locality on Seco Creek at Rothe Ranch, three miles north of D'Hanis, the genus is very common. On Hondo River the horizon has been eroded in all exposed places so that no specimens were found at this locality. The presence of the large echinoid *Ananchytes texana* indicates a more typical beach condition than is evinced by any fossils of the same horizon to the east. Lateral changes, both biologic and physical, are common, especially in deposits paralleling an old shore line, and the proximity of these deposits to the shore line will readily explain the observed lateral variations.

The physical characters of the Escondido to a great extent have determined the class of relief for the country immediately underlain by this formation. To some extent the drainage has modified the topography of the area but in general two types of relief are in evidence. These are dependent upon the lithology of the Escondido. However, both in turn are modified by drainage features. The basal 200 feet of the Escondido, occupying the surficial area of the Escondido north of and approximately paralleling the Southern Pacific Railroad across the county, are as distinctive in relief as in physical characters. For the most part these basal 200 feet are composed of soft arenaceous clays, shales, and marls, with practically no limestone strata. As a result, the surficial area of the lower 200 feet of the Escondido is practically a plain covered by a thin veneer of the Leona formation, through which the more resistant material of the Escondido outcrops as small ledges.

The upper 500 feet of the Escondido become much more calcareous especially toward the top, and the material is generally highly indurated, with the exception of the shale partings. As a result, the topography of the Escondido becomes more pronounced toward the south. .With the exception of the immediate stream valleys, which are directly determined by agencies other than the physical properties of the strata, there are no plains. The more resistant lime-



OSTREA CORTEX HORIZON. VERY FOSSILIFEROUS,HARD,LIGHT TO DARK BROWN LIMESTONE STRATA AVERAGING FROM 6 INCHES TO 2 FEET IN THICKNESS. INTERBEDDED WITH THE LIMESTONE LEDGES ARE THIN CLAY SHALE STRATA. THE UNWEATHERED CLAY SHALE IS BLUISH BUT WEATHERS TO BLUE-BROWN OR BROWN.

SPHENODISCUS PLEURISEPTA HORIZON. PREDOMINANTLY FINE-GRAINED, VERY FOSSILIFEROUS,HARD,YELLOW,ARENACEOUS LIMESTONES WITH INTERBEDDED,SOFT CALCAREOUS,SHALY CLAY STRATA. THE LIMESTONES ARE GENERALLY FROM 2 TO 3 FEET IN THICKNESS. THE INTERBEDDED CLAYS ARE FROM 1 TO 2 FEET THICK THE CHIEF FOSSILIS ASSCIATED WITH OSTREA CORTEX ARE NUCULA,PELECYPODA AND A FEW GASTROPODA.

NO DEFINITE HORIZONS WERE ESTABLISHED IN THIS PART OF THE ESCONDIDO. SOFT,YELLOW,ARENACEOUS CLAYS COMPOSE THE GREATER PART OF THIS 500 FEET OF SECTION. THE CLAYS ARE SLIGHTLY FOSSILIFEROUS. INTERBEDDED WITH THE CLAYS ARE THIN LEDGES OF HARD,BROWN,ARENACEOUS LIMESTONES FROM 6 INCHES TO 2 FEET IN THICKNESS. THE LIMESTONES ARE FINE - TEXTURED AND GENERALLY QUITE FOSSILIFEROUS. THERE ARE NUMEROUS GASTROPODS,PELECYPODS,AND SOME THIN OBLONG OYSTER SHELLS WHICH MAY BE THE VENTRAL VALVES OF SMALL OSTREA CORTEX OR OF SOME OTHER SMALL CRETACEOUS OYSTER. NO DEFINITE HORIZONS COULD BE IDENTIFIED WHICH COULD BE POSITIVELY CORRELATED AT ISOLATED OUTCROPS

SOFT YELLOW CLAY WITH A FEW THIN LIMESTONE LEDGES TOWARD THE TOP. THE HORIZON IS PREDOMINANTLY SOFT,YELLOW,ARENACEOUS CLAY CONTAINING A FEW FOSSILS,CHIEFLY SMALL PECTENS AND PELECYPODS. THERE IS AN INCREASE IN LIME OVER THE HORIZON BELOW AND A DECREASE IN THE AMOUNT OF SAND. THIS HORIZON FURNISHES THE CLAY USED FOR THE BRICK YARDS AT D'HANIS. IN THE CLAYS ARE RED CLAY SEAMS FILLED WITH SELENITE AND DEEP RED LIMONITE BANDS FROM 1/2 to 2 INCHES THICK. THESE LIMONITE BANDS ARE FULL OF SHARKS TEETH,GENERALLY IN AN EXCELLENT STATE OF PRESERVATION

VARIEGATED,SHALY CLAY,RED,BLUE,YELLOW,VERMILLION PREDOMINATING. THE ONLY FOSSILS OBTAINED WERE A FEW SMALL PECTENS.

ANANCHYTES TEXANA HORIZON. ASSOCIATED WITH THIS ECHINOID ARE NUMEROUS MASSIVE GRYPHEA VESICULARIS. NONE OF THE SMALL VARIETY OF GRYPHEA VESICULARIS WERE FOUND. THE MARL OF THIS HORIZON IS DISTINCTLY ARENACEOUS AND IN PLACES IS ALMOST PURE SAND. SO FAR AS KNOWN ANANCHYTES TEXANA IS CONFINED TO THE HORIZON. IN ADDITION TO THE FOSSILS MENTIONED ARE A NUMBER OF BIG LOOSELY COILED TURRILITES AND A FEW SMALL PECTENS

EXOGYRA PONDEROSA HORIZON. SOFT,YELLOW CLAY,BECOMING MORE ARENACEOUS TOWARD THE TOP. EXOGYRA PONDEROSA IN ABUNDANCE. THOUGH NO EXOGYRA COSTATA WERE FOUND IN THIS LOCALITY,THEY ARE ABUNDANT IN THIS HORIZON EAST OF THE MEDINA RIVER. THE EXOGYRA PONDEROSA HORIZON IS VERY DISTINCT FROM THE AUSTIN CHALK SPECIES OF THE SAME FAUNA. ASSOCIATED WITH THE EXOGYRA ARE NUMEROUS MASSIVE GRYPHEA VESICULARIS.

ARENACEOUS CLAY YELLOW AND SOFT. MORE CLAY AND LESS CALCAREOUS MATTER THAN THE HORIZON BELOW. POORLY FOSSILIFEROUS,WITH PYRINA,VENERICARDIA AND GRYPHEA VESICULARIS CHIEFLY OF THE SMALL VARIETY.

GRYPHEA VESICULARIS HORIZON. AN ARENACEOUS,GLAUCONITIC MARL; PRACTICALLY A SHELL CONGLOMERATE OF GRYPHEA VESICULARIS NO OTHER FOSSILS WERE FOUND.

ARENACEOUS MARL OVERLYING ANACACHO ASPHALT ROCK. POORLY FOSSILIFEROUS WITH PECTEN AND VENERICARDIA SP.

Figure 5

Compiled geologic column of the Escondido formation in Medina County. Scale, 1 inch=100 feet.

stone ledges form protective caps for the softer material and the area in general is covered by a deposit of the Uvalde formation. The Uvalde flint and caliche also assist in protecting the hills from erosion. Thus the general relief of the Escondido is directly dependent upon the physical nature of the strata composing the formation.

THE CRETACEOUS-EOCENE CONTACT

Across Medina County the contact between the Cretaceous and the Eocene is well established. The uppermost Cretaceous in the county is the *Ostrea cortex* horizon of the Escondido which lies above the *Sphenodiscus pleurisepta* horizon. To the west across Uvalde County the *Ostrea cortex* horizon still remains as the uppermost Cretaceous. Farther to the west, in the United States and in northern Mexico, the uppermost Cretaceous is much higher than the highest Escondido in Texas. Since there is a rapid increase in the thickness of the Upper Cretaceous to the west of Medina County by the addition of higher Escondido and probably even more recent Cretaceous material, it is evident that the contact between the Cretaceous and the Eocene in Medina County lies well upon the hiatus which in Medina County separates the Escondido from the Midway. How great a break there is between the Cretaceous and the Eocene in Medina County is not known. Throughout the entire contact no discordance of dip could be detected. There is, however, considerable lithologic dissimilarity and a marked paleontologic break. The uppermost Escondido in Medina County consists of hard yellow-brown fossiliferous layers of limestone interbedded with thin shale strata. The overlying Midway consists of medium hard, impure, yellow, glauconitic limestone with small clay concretions. There is thus a marked contrast lithologically between the uppermost Cretaceous and the lowest Eocene in Medina County.

The paleontologic break is much more pronounced. Though some of the more hardy genera survive the hiatus, probably migrating to the west with the sedimentation and returning to the east with the early Eocene submergence, no species are known to bridge the hiatus. In the higher

Cretaceous strata to the west which in part at least represent the hiatus in Medina County, there should occur forms intermediate between the forms of the Cretaceous and the Eocene of Medina County.

The surficial Cretaceous-Eocene contact across Medina County is not in all places a contact between the Escondido and the Midway. West of Noonan the Wilcox group overlaps the Midway and rests directly upon the Escondido. These conditions exist in the entire area of Medina County, west of Noonan, and very probably extend for some distance into Bexar County. Thus the actual contact between the top of the Cretaceous and the base of the Eocene lies to the south of the surface Cretaceous-Eocene contact and is covered by the later overlapping Wilcox beds.

West of Noonan the Cretaceous-Eocene contact in Medina County lies approximately a half mile to the south of the course of the Southern Pacific Railroad, to which it conforms. At Noonan, however, the Midway extends to the north from under the Wilcox, cutting across the Southern Pacific Railroad just west of Noonan, and continuing immediately to the north of the railroad as far west as the Castroville-Pearsall road. From this locality it swings southwest and passes just south of Enterprice, thence northwest, crossing the Hondo River approximately one and one-fourth miles north of the Elstone bridge. A quarter mile north of this locality some hard, brown, unfossiliferous Wilcox limestone lenses occur in the creek bed. At this locality the overlapping Wilcox has been folded or faulted down below its normal level and has been protected from erosion though it has been removed from the surrounding area.

West of the Hondo River the Cretaceous-Eocene contact is a contact between the Escondido and the Midway. The contact is found in the west bank of Live Oak Creek seven miles south of Hondo. The Midway here overlying the Escondido is found in the base of a Wilcox bluff south of the creek. On the road from Hondo to Butts Gin, the contact is found at the base of the escarpment eight and one-half miles south of Hondo.

On the old road leading slightly east of south from

D'Hanis, seven and one-half miles from D'Hanis, the Cretaceous-Eocene contact is found at a northwest-facing escarpment. The Midway exposure is about 15 feet thick. To the north are the hard brown limestones interbedded with brown shales and carrying a Cretaceous fauna. One and a quarter miles southwest of this locality on the new road from D'Hanis to Yancey, the contact between the same strata is again observed. On the road leading almost due south from D'Hanis to the old Captain Smith Ranch, the Cretaceous-Eocene contact was found eight and one-half miles from D'Hanis. The Midway here overlies the hard, brown limestones of the Escondido. From this locality the contact was traced southwest, crossing West Squirrel Creek half a mile southeast of the Johnson Ranch, thence bearing slightly to the west and entering Uvalde County as a bluff one mile southeast of the Schuddemagen Ranch.

THE CENOZOIC

EOCENE

About 1000 feet of Cenozoic deposits are exposed in Medina County. For the most part the series is composed of arenaceous, argillaceous, glauconitic limestones becoming more argillaceous and arenaceous toward the top; passing through calcareous shales, with little limestone, into arenaceous shales; and terminating in the coarse calcareous sandstone. As a rule the material is coarser and much less indurated than the Upper Cretaceous series. In ascending order there are in the Eocene of Medina County, the Midway group, composed of the Elstone and Squirrelcreek formations; the Wilcox group, embracing the Buttsgin and the Seco formations; and the Carrizo formation of Claiborne age.

MIDWAY GROUP

Overlying the Escondido formation of the Upper Cretaceous and showing a distinct break both in lithology and paleontology, is the Midway Group of the Eocene. A closer resemblance in lithology is noted between the lower Escondido and the Midway than between the upper Escondido and the Midway. Both the Elstone and the Squirrelcreek formations are impure gray and yellow-gray limestones, but are very easily distinguished. The superficial areas of both these formations are about equal and taken together they have less areal exposure than any of the other Eocene formations.

West of Noonan the Midway is concealed by the northward transgression of the Wilcox group, which overlaps the Midway and rests directly upon the Escondido of the Upper Cretaceous. Though the Midway outcrop has been identified across the entire county to the west of Noonan, almost the whole surficial area is afforded by the extended outcrops in the vicinity of Noonan, Haass, and Elstone; on the summits of the ridge three miles north of Butts Gin; and on Squirrel Creek at and to the north of the old Captain Smith ranch-house. Between the localities just mentioned the surface exposure of the Midway is limited to from one-quarter to one-half mile in width.

The Elstone Formation

In the bed of the Hondo River one-quarter mile above the bridge at Elstone, is an impure, yellow, glauconitic limestone which in Medina County is the basal formation of the Midway Group. Some 30 feet of this limestone are exposed and it is uniform throughout. The exact thickness of the Elstone formation is not known, but is probably between 30 and 40 feet. The material is a medium coarse-grained limestone, moderately soft, containing considerable glauconite and a number of poorly preserved fossil remains. The following specimens were collected at this locality and indicate the Eocene age of the containing strata:

Venericardia alticostata
Turritella mortoni
Leda cf. *elongatoida*
Ostrea aff. *crenulimarginata*
Glycimeris sp.

This glauconitic Elstone limestone is readily identified west of the Hondo River. To the east, however, care must be taken that it is not confused with the overlying Squirrelcreek limestone, which east of the Hondo River assumes a glauconitic phase not encountered west of the river. The Elstone formation is much softer than the underlying Buttsgin formation of the Escondido, is coarser and entirely different in color and composition. It is highly glauconitic, while glauconite is practically absent from the Upper Escondido. The Elstone formation is also easily distinguished from the overlying Squirrelcreek limestone west of Hondo by the absence of glauconite in the Squirrelcreek limestone and the presence of numerous brown calcite crystals and concretions. The Squirrelcreek limestone is much harder and is more nearly a true limestone. The amount of sand is markedly greater in the Elstone formation than in the Squirrelcreek limestone.

The areal exposure of the Elstone limestone is determined to a great extent by the Squirrelcreek limestone, for in the absence of the Squirrelcreek limestone as a protective cap the glauconitic limestone disintegrates rapidly. The areal extent of the Elstone formation in the Hondo River north of the Elstone bridge is due to the fact that at this locality it is folded or faulted considerably below its normal position. At its normal elevation it is found immediately underlying the Squirrelcreek limestone on a hill half a mile east of the Elstone bridge and some 30 feet above its position in the creek bed. A small fault or an abrupt steepening of dip can be seen along the south side of the exposure, but on all sides it is so concealed by alluvium that it is impossible to determine how much folding or faulting has taken place.

Two other small localities of the Elstone formation are found on the roads leading south from Hondo. On the east road which leads to Yancey via Mofield Gin, the exposure is found seven miles south of Hondo at the west bank of Live Oak Creek at the foot of the escarpment which is chiefly composed of the Buttsgin formation of the Wilcox. Alluvium covers practically the entire formation at this locality. On the other road from Hondo leading to Yancey via Butts Gin the exposure is found at the foot of the same escarpment eight and one-half miles south of Hondo. Here, too, little of the formation is exposed. Between these localities only very small exposures were found. In the vicinity mentioned above, the Midway is apparently below its normal position, and probably has been affected by folding or faulting.

The chief exposure of the Elstone glauconitic limestone west of the Hondo River is found from eight and one-half miles to ten miles east of south from D'Hanis on the Yancey road. At this locality it is found covering the hills at a slightly lower level than the Squirrelcreek limestone. The Squirrelcreek limestone has evidently been only recently eroded and the glauconite, though weathered to a soft sand, has remained in place. Though the formation has considerable surface exposure at this locality, the greatest vertical thickness was from two to three feet. In the area surrounding Squirrel Creek the Elstone formation outcrops as a border around the Squirrelcreek limestone. Again on the banks of the west branch of Squirrel Creek above the old Captain Smith ranch-house, the glauconite is found. Its exposures at this locality are poor because of the cover of alluvium.

In the vicinity of Haass and Noonan the Elstone formation is found underlying the Squirrelcreek limestone. Though at this locality the Squirrelcreek limestone is very glauconitic, the Elstone formation can be distinguished by the absence of the brown calcite crystals and concretions, which are so characteristic of the Squirrelcreek limestone. To the west of Noonan the Wilcox overlap conceals the entire Midway Group.

The Squirrelcreek Formation

Above the Elstone formation and west of the Hondo River, showing decided lithologic contrast to the underlying glauconitic limestone, is the Squirrelcreek limestone. This formation of the uppermost Midway exposed in Medina County is named from its largest exposure on the east and west branches of Squirrel Creek above the old Captain Smith ranch-house. Its entire surficial exposure in Medina County is about the equal of the Elstone formation. The principal exposures of the Squirrelcreek formation are found capping the points of greatest elevation east of Hondo River. West of the Hondo River there is a remarkable uniformity throughout the formation, both in lithology and paleontology. A complete surface section of this formation has never been found, but from the information afforded, there are known to be at least 75 or 100 feet.

Lithologically the Squirrelcreek formation is an impure, medium hard, gray limestone, containing small balls of clay about a half inch in diameter and much brown calcite both in the form of single crystals and in the nature of concretions. Most of the fossils are to a great extent, or entirely, replaced by this calcite. This mineralogic peculiarity is one of the chief lithologic criteria for the identification of the formation. The Squirrelcreek limestone can readily be distinguished from the underlying Midway through the presence of this calcite.

In localities there is a less amount of brown calcite and over such areas the limestone is lighter in color and is a purer gray instead of being partly yellow. In the localities where the limestone is a lighter gray, the calcite is gray to white and there are few clay inclusions. Since these clay concretions carry some iron, it is quite probable that the color which stains the calcite to a brown is derived from the iron in these clay inclusions.

Upon freshly broken surfaces the limestone has a spotted or mottled appearance which is dependent upon the color, size, and frequency of occurrence of the brown calcite and clay inclusions. The fossils which have been replaced by calcite sometimes retain the original gray or white color of the calcite, but generally they are stained to the same brown color as the majority of the calcite. On fresh surfaces the limestone is gray but generally weathers lighter upon exposure. In places organic stains have colored it darker. After being exposed it rapidly disintegrates and weathers to boulders generally 12 to 18 inches in diameter.

The greatest thickness in a single section west of Hondo River is in the bank of West Squirrel Creek, one and one-half to two miles above the old Captain Smith ranch-house. Forty feet of the limestone are here exposed.

In practically all places the Squirrelcreek limestone carries a good fauna, but unbroken specimens are very difficult to obtain. The fossils upon weathered surfaces soon lose their specific characters and on account of the comparative hardness between the limestone and the calcite which has replaced the fossils, it is almost impossible to extract the specimens intact.

The common Midway fauna is present and is composed of *Turritella mortoni* (common), *Turritella humerosa, Natica* sp., *Cytherea* sp., *Lucina* sp., *Leda* sp. cf. *elongatoidea* (very abundant), *Venericardia alticostata* (common), *Venericardia planicostata* (common), *Ostrea pulaskensis, Ostrea crenulimarginata, Cucullea saffordi.*

Lateral Variation in the Squirrelcreek Formation

East of Hondo River there is a distinct break in the nature of sedimentation in the Squirrelcreek limestone. In this part of the county the formation still retains its brown calcite which is also lacking in the underlying Elstone glauconitic limestone, but it has assumed a glauconitic phase with a greater clay content. In this respect there is much greater similarity between the two formations of the Midway Group east of Hondo River than west of it. The change in the Squirrelcreek limestone from a concretionary, argillaceous, glauconitic limestone, to a non-glauconitic phase with a loss of kaolin and an increase in calcareous matter, seems to have been sudden. As no lateral variation in the nature of the sediments of any other formations was found, with the exception of the Austin chalk and the Anacacho limestone, the cause of variation in the Squirrelcreek limestone is difficult to explain. In the overlying Wilcox and Carrizo no corresponding change could be found.

It is not known if the entire thickness of the Midway is exposed in Medina County. Since to the east of Noonan the entire Midway is concealed by the overlapping Wilcox, it is quite probable that to the west of this locality the uppermost Midway is also concealed.

East of Hondo River the principal locality of exposed Midway is in the vicinity of Haass. The hills to the south of Haass are entirely composed of the Squirrelcreek formation, thus giving it a thickness of at least from 75 to 100 feet. At this place it is highly glauconitic and very fossiliferous. The formation is also found at various points between Haass and the Hondo River and between Haass and Noonan.

West of the Hondo River, there are two principal localities, the one already mentioned in the vicinity of the old Captain Smith ranch-house, the other on the D'Hanis-Yancey road eight to ten miles southeast from D'Hanis.

On the road from D'Hanis, west of south of the direction of the old Captain Smith ranch-house, the Squirrelcreek limestone is first encountered as the cap rock of a hill eight and one-half miles from D'Hanis. Here it overlies the Elstone glauconite which in turn rests upon the Buttsgin formation of the Wilcox. Some 20 feet of the limestone are poorly exposed in a vertical section. East of the road and conforming in line of outcrop to the topography of the area, the Squirrelcreek limestone extends about a quarter mile farther to the north and thence around the hills for which it forms the cap rock. West of the road the outcrop extends about due southwest and the formation is well exposed on West Squirrel Creek, one and one-quarter miles southeast of the Johnson Ranch. About 40 feet of the limestone are exposed in the southwest bank of the creek. At this locality a small fold or fault has placed the Squirrelcreek limestone lower than the position it should normally occupy. No detailed information of this disturbance could be obtained because of the cover of caliche, Uvalde flint, and wash. From northwest to southeast, the exposure narrows, the amount of exposure being affected by the drainage features of the area.

On the new road from D'Hanis to Yancey, eight and one-quarter miles east of south from D'Hanis, the Squirrel creek limestone is again found capping the highest hills. Here the sequence of formations is the same as that found in the remainder of the county. The section affords only some three feet of the limestone. On the old road from D'Hanis to Yancey, seven and one-half miles east of south from D'Hanis, 15 feet of the Squirrelcreek limestone cap the summit of a prominent hill. The limestone is moderately hard, light gray and contains *Cucullaea macrodonta, Venericardia alticostata,* and *Ostrea crenulimarginata,* with abundant *Leda* sp. The outcrop is readily identified both lithologically and paleontologically as the Squirrelcreek formation of the Midway Group. In places in this locality, three-fourths of a mile to the south, the Squirrelcreek limestone has been eroded, and the Elstone formation is exposed.

With the exception of a few small exposures there are no other outcrops of the Squirrelcreek limestone of any mentionable size between the above locality and Hondo River.

On the west road, south from Hondo to Yancey, via Butts Gin, the Squirrelcreek formation is poorly exposed in the road-bed eight and one-half miles from Hondo. Only two feet in vertical section are here exposed. On the east road to Yancey via Mofield Gin, the limestone outcrops in the south bank of Live Oak Creek at the foot of the escarpment. The outcrop is found at the base of the escarpment overlying the Elstone glauconitic limestone and underlying the Buttsgin formation of the Wilcox.

On the west side of the road half a mile south of the Elstone Gin, the Squirrelcreek limestone outcrops. It overlies the Elstone formation, but the contact can be seen only very locally because of the covering of the Leona formation. The position and relative elevation of the Squirrelcreek at this outcrop with the outcrop next farther east, show that there is a fault or fold which has placed this outcrop below its normal level. It is impossible to obtain more definite information because of the covering by the Leona formation.

THE WILCOX GROUP

In Medina County, the Wilcox Group is practically unfossiliferous. Some few specimens resembling plant remains were collected but no animal life was found. Upon lithologic characters this group has been divided from bottom to top into the Buttsgin and the Seco formations. The entire thickness of the Wilcox is not exposed at the surface in Medina County because of the overlapping Carrizo sandstones. The Carrizo overlap though at different places concealing various beds of the Wilcox, does not completely cover any but the uppermost part of the group, namely, that part of the Wilcox above the Seco shales and underlying the iron-bearing members of the Carrizo.

The thickness of the Wilcox is about 600 feet.

The Buttsgin Formation

The greater part of the Wilcox Group is represented in Medina County by the sandstones and shales of the Buttsgin formation. This formation for the most part is composed of large calcareous sandstone lenses and arenaceous limestone lenses imbedded in arenaceous shales and clays. The sandstone lenses are predominantly brown on freshly broken surfaces and in general have a faint banded structure. These lenses vary considerably in size but generally are 20 to 30 feet in breadth and four to five feet in thickness. There apparently is no regularity of occurrence of the lenses, for they are found at practically all elevations throughout the formation. Zones of these lenses have been observed to occupy the same horizon for one-fourth to one-half mile where they are replaced by arenaceous shales or thinly-bedded, brown, banded, calcareous sandstone.

The thin-bedded and banded calcareous sandstones of the Wilcox are easily differentiated from the thin, brown, calcareous sandstone and arenaceous limestone ledges of the Escondido, because of their banded nature. No banded material was found in the Escondido. The sandstone lenses of the Buttsgin formation, though not as distinctly banded as the thin-bedded limestones of the same formation, can readily be identified. They are also considerably coarser than the thin-bedded, fine, compact, arenaceous limestones and calcareous sandstone ledges of the Escondido.

There is considerable similarity between the gray, hard, sandstone lenses of the Wilcox and the sandstones of the Carrizo. Upon close examination, however, the Carrizo sandstones are found to be much coarser, less indurated, and distinctly cross-bedded. No fossils were found either in the sand lenses of the Wilcox or in the Carrizo sands.

There is a decided increase in the amount of sand from the base to the top of the Wilcox. The basal 75 to 100 feet are quite calcareous; sufficiently so, that the lenses are common and in most cases are brown or gray; but the amount of sand is considerably less than is contained in the lenses of the Upper Wilcox. The lower lenses are more properly referred to as arenaceous limestone lenses while in the upper part the lenses are distinctly calcareous sandstone. There is enough sand in the upper part of the Wilcox to afford a deep brownish-red sandy soil.

At various localities these lenses of the Wilcox can be seen. The largest exposure is approximately a mile above the bridge over the Hondo River at Elstone. At this locality there are large masses of slightly cross-bedded sandstone. The freshly exposed surfaces are gray or light brown and weather to a deep brown. In the east bank of the Hondo River for over one-fourth of a mile there is exposed this horizon of sandstone lenses. Wash from the river has concealed all but the sandstone lenses, but as is generally the case, the lenses are imbedded in yellow or brown calcareous shales. These lenses are much thicker and coarser than the underlying fine-grained arenaceous limestones of the Escondido formation and the Wilcox lenses contain no fossils. The thin ledges of the Escondido are in general quite fossiliferous.

An evidence of the transgression of the Wilcox formation is found at this locality. The basal Wilcox here has transgressed northward, overlapping the Midway and resting directly upon the Escondido. Over the remainder of the area, west of Noonan, the Wilcox, which once undoubtedly covered the Midway and rested upon the Escondido, has been eroded north of the surficial exposure of the Midway. A structural depression, either a fault or a syncline, has placed the Wilcox in this locality lower than the general level of the formation and for this reason it has been preserved as an outlier of the Wilcox formation.

The entire area south of a line through this point and paralleling the present surface exposures of the Midway and Wilcox was once probably covered with Wilcox which had overlapped the Midway and rested directly upon the Escondido. How much farther upon the Cretaceous area the Wilcox overlapped is not known.

To the east of Noonan through the remainder of Medina County and western Bexar County there is no Midway exposed, and in the area where Midway should normally be expected, the brown and yellow arenaceous shales with arenaceous limestone lenses of the Wilcox Group are found. These beds belong to the Buttsgin formation of the Wilcox and show that the Wilcox overlap was a progressive one in comparison to the Carrizo overlap, which was regressive.

West of the Hondo River the land is topographically high and the Wilcox, if deposited north of the Midway outcrop, has been eroded. In the escarpment immediately south of Live Oak Creek, seven miles south from Hondo, the Wilcox is found overlying the Midway which in turn rests upon the Escondido. Though a great part of the section is covered by Uvalde flint and caliche, the sandy shales are fairly well exposed in the road-bed, at the base of the hill. In some instances these shales are almost pure sand but generally they are quite calcareous and should be referred to as calcareous shales. Only some 10 feet of the basal Buttsgin formation are there exposed at the surface. At the top of the hill limestone lenses are found embedded in the shales. The shales are from light gray to yellow and brown in color.

A typical exposure from which this formation of the Wilcox was named is found at Butts Gin approximately six miles northwest from Yancey. The exposures are in the bed and tributaries of the branches of Seco Creek in this locality and consist of hard, gray-brown, arenaceous limestones and calcareous sandstones embedded in calcareous shales. The material weathered from this part of the formation is a deep brownish-red sandy soil. Another good exposure of the horizon of these arenaceous limestone lenses is found west of Squirrel Creek and two and one-half miles southeast of the old Captain Smith ranch-house. The area for some three or four square miles shows these lenses to be at or near the surface. In some places they are very much cross-bedded.

In a creek bed at the town of Yancey and two and one-half miles southeast of this locality, the gray limestone lenses of the Buttsgin formation are abundant.

In Seco Creek, three miles south of west from Yancey, the contact between the Buttsgin formation and the overlying Seco formation of the Wilcox is found. Overlying about 20 feet of yellow-red and brown sandy shales are some five feet of deep red, thin-bedded, sandy shales. These shales have been mapped as the Seco formation of the Wilcox group.

Estimates of the surface exposures of the Wilcox and records from subsurface explorations place the thickness of the Buttsgin formation at approximately 500 feet.

The Seco Formation

The lithology of the upper shales of the Wilcox Group in Medina County readily separates them from the underlying Buttsgin formation. The limestone and sandstone lenses are very much reduced in numbers and the entire formation practically consists of variegated shales. Though there are some brown and yellow shales, the majority is deep red in color and contains iron. When seen in sections they are readily identified and when present under the surface and not too deeply covered by Uvalde flint or caliche, the surface of the ground is covered with small, flat, deep red pieces of shale. These fragments are about three-fourths to one and one-half inches long, one-half to three-fourths inches wide, and one-fourth inch thick. Frequently the ground is very deeply covered with these particles of deep red shale. The thickness of the shale particles is determined by the thickness of the bedding planes in the original formation and the length and breadth are due to the resistance of the material. As their hardness is sufficient to permit of only very local transportation, the weathered particles are found practically overlying the shales. The soil derived from these shales is a much deeper red than that derived from the Buttsgin formation.

On account of the poorly resistant nature of the shales themselves and because of the caliche and Uvalde flint cover, or the weathered material of the Carrizo sandstone, which is often present, the shale outcrops are quite rare.

In addition to the exposure mentioned on Seco Creek there is an exposure of the Seco shales in a cut on the road to Round Pens, one mile southwest of ZigZag. At this locality, about three feet of the shales are exposed in a ditch at the side of the road. The entire surface of the ground, however, is covered with the weathered material from the shales. Again on the Devine road, one-half mile east of ZigZag, these shales are seen in an excavation at the east of the road, and they dip 2° to the southeast of this locality. One and one-half miles north of this locality, the shales dip 3° to the southeast.

At the bridge over Francisco Creek the shales are again exposed at the side of the road and in the creek banks. The dip is 2° to the northeast. Two miles east of this locality the dip is 5° to the northeast.

At a hill on the south of the road three miles northwest of Devine the shales are well exposed. At this locality they are thin-bedded, of a sandy nature, and deep red in color. The dip is from 4° to 5° south of west. Thus in the area between Black Creek and Francisco Creek, south of the road east and west, three miles south of Biry Gin, and the road east and west one mile north of ZigZag, there is a structure, as indicated by the observations taken at the outcrop of the Wilcox shales just mentioned.

From subsurface excavations, measurements of 100 feet of the Seco formation have been obtained and this thickness is probably the average throughout the county.

THE CLAIBORNE GROUP

The Carrizo Formation

Overlying the uppermost Wilcox beds in the south and southeastern part of the county and extending northward almost to the Cretaceous-Eocene contact, is the Carrizo sandstone. Considerable variation in the conditions under which the deposition of the formation occurred is evinced by the nature of the sediments.

Though it is quite probable that the base of the Carrizo formation is concealed by the northward transgression of its upper members, the coarse, deep red, iron-bearing sandstone, one and one-fourth miles west of Devine and immediately west of Seco Creek on the Ward Ranch road, lies not far above the base of the formation. The exact thickness of this basal member could not be measured since no complete section is exposed and no well logs could be obtained in the area. However, a single section of 50 feet has been measured one mile west of Devine, and it is very probable that the entire thickness of the basal member of the Carrizo is from 75 to 100 feet.

In various localities this basal member of the Carrizo sandstone rests upon different beds of the Wilcox. However, the northern limit of the basal Carrizo members is marked by the Seco shales of the Wilcox. Only the higher gray sandstone of the Carrizo extends farther to the north.

Within the basal iron-bearing member of the Carrizo sandstone itself there is considerable variation. The lowest beds found contain a much less amount of iron than the upper part of the formation and, in addition, are exceedingly cross-bedded. Above these beds are the deep red-black, iron-bearing strata which evince much less cross-bedding.

In general the basal member of the Carrizo is chiefly composed of coarse quartz grains and pebbles cemented by a ferruginous material. Inclusions of clay ironstone of considerable size are frequent in the basal 100 feet of the Carrizo formation. It is quite probable that it is from these inclusions that the red coloring of this member of the formation is obtained, as it is evidently an iron stain and the sandstone is so coarse that penetration of the iron to a considerable depth is possible. In the vicinity of the clay ironstone pockets the sandstone is more deeply colored, and in localities removed from such pockets the sandstone is quite gray.

Many of the quartz pebbles composing the greater part of the basal Carrizo are 3 mm. in diameter and well rounded. Most of them, however, are 1 mm. in diameter.

The remaining sandstone of the Carrizo formation is more uniform in color and texture. It is predominantly gray and generally cross-bedded. In some localities it is highly indurated, while in others it is practically an unconsolidated gray sand. On exposure the sandstone weathers darker and is stained to a brown or black in places by limonite weathered from the small inclusions.

The upper part of the Carrizo formation is a calcareous sandstone of medium coarseness with thin, interbedded layers showing a cone-in-cone structure. Sometimes the sandstone is quite evenly bedded and massive. In weathering it forms a deep gray sand, and the more indurated ledges cap the gray Carrizo sand hills of the south and southeast part of the county. These caps in most places are covered by deposits of Uvalde flint or weathered residual of the sandstone itself.

The lowest geologic exposure of the Carrizo formation in Medina County is one and one-fourth miles west of Devine. At this locality a red sandstone hill immediately west of the road exposes the lower, less ferruginous beds of the basal iron-bearing members. The basal part of the section is covered with red detrital material from above, while the top of the hill is capped with Uvalde flint.

Between these top and bottom coverings some 60 feet of coarse, red, cross-bedded sandstone are exposed. That the color is not uniformly distributed throughout the strata is very evident and the source is apparently from the inclusions of clay ironstone. Throughout the section the cross-bedding is uniformly 15° to the southwest. It was not possible to obtain any information in regard to the dip, except that it seemed to be to the south or southwest.

Approximately two miles northwest of the exposure just mentioned the iron-bearing beds are exposed. At this locality they are a deep red or reddish-black.

The iron-bearing horizon is again in part exposed one mile northeast of Bailey Lake which is three miles southeast from Yancey. In a shaft here located, eight feet of the coarse deep red to reddish-black sandstone were passed through and the variegated Seco shales of the Wilcox encountered. At the bottom of the shaft 82 feet below the base of the Carrizo, the Seco shales had not been penetrated.

Again at the exposure previously mentioned on the Ward Ranch road just west of Seco Creek about 10 feet of the same iron-bearing horizon were found. Here also the basal iron-bearing Carrizo overlies the variegated Seco shales, which in turn rest upon the Butts Gin formation of the Wilcox. The section at this locality shows:

	Feet
Claiborne-Carrizo formation:	
Coarse, deep red to reddish-black, iron-bearing sandstone..	4
Wilcox-Seco formation:	
Variegated shale predominantly yellow, red, brown; some purple and gray..	45
Wilcox-Buttsgin formation:	
Brown, unfossiliferous, calcareous sandstone, medium texture	6

Capping a hill at the east of the road one mile east of south from the Medfrio test are 15 feet of the same iron-bearing horizon. At this locality it is evenly bedded and uniformly red to black.

At all localities observed this basal member of the Carrizo formation dips to a greater degree toward the southeast than does the overlying upper Carrizo or underlying Wilcox. In general these iron-bearing beds are inclined from 8° to 10° to the southwest.

From all observations the exact base of the Carrizo lies to the south of the line demarking the Wilcox-Carrizo contact. A gradual submergence of the land area to the north caused a northward transgression of the overlying Carrizo strata and this overlap has concealed the base of the Carrizo. The depression of the land area probably began contemporaneously with the Carrizo sedimentation and continued throughout the entire Carrizo deposition, for in the upper part of the Carrizo formation the material is plainly a deeper water deposit. The Mount Selman formation overlying the gray Carrizo sandstone in northern Frio County clearly indicates a more shallow water condition. Thus the time interval of the gradual submergence of the Wilcox shore line is measured by the overlap of the Carrizo formation. The abnormal deposition throughout at least the upper part of the Carrizo formation marks the time interval between the normal sedimentations of the Wilcox and the Mount Selman formations.

Three principal exposures of the coarse gray Carrizo sandstone were found in the county. Though isolated outcrops are quite frequent and the weathered material common, it is difficult to find exposures at which sections can be taken. Unless quite firmly indurated the sandstone readily breaks down to a coarse, deep gray, sandy soil.

The easternmost exposure of the Carrizo formation suitable for sectioning is a small hill three miles northeast from Devine. At this locality the sandstone is massive and moderately hard, affording a cap for the softer Seco shales of the Wilcox beneath. The section at this point is:

	Feet
Claiborne-Carrizo sandstone:	
Coarse, gray, cross-bedded sandstone, massively bedded, and containing small concretions of limonite. The hill is free from the Uvalde flint which conceals the Carrizo sandstone certainly capping the hills in the vicinity of ZigZag and Round Pens.	8
Wilcox-Seco formation:	
Variegated shales, principally yellow, red, blue, gray, brown, with some brown sandstone concretions.	28

A second exposure of the Upper Carrizo is located on the Hondo River three and one-half miles south of Elstone crossing and one-half mile south of the Lon Moore crossing. The thickness of the section here exposed is 20 feet and the strata are moderately hard, massive, strongly bedded, grayish, calcareous sandstone. In places the sandstone is extremely hard and has a sub-crystalline appearance, while in other places it is quite soft and unconsolidated.

On freshly broken surfaces the sandstone is uniformly light gray and weathers to a darker gray. The local dark brown color is due to iron oxide from the limonite concretions embedded in the massive gray sandstone. The thin layers between the massive ledges sometimes show a cone-in-cone structure.

From the nature of the residual soil around the Carrizo outlier, the Buttsgin formation of the Wilcox is undoubtedly present under the Carrizo; but the actual contact, with the exception of a locality at the northeastern end of the exposure, is concealed by the residual Wilcox or by alluvium.

In the southwestern part of Medina County between Squirrel and Seco creeks, one mile east of the old Captain Smith ranch-house, the largest single outcrop of the gray Carrizo sandstone forms the entire hill at this place. Though the actual contact of the Carrizo with the underlying Wilcox can not be seen because of talus at the base of the hill on all sides of the Carrizo outcrop, the formation has been identified as the Buttsgin formation of the Wilcox Group. There are at least 60 feet of the massive, evenly-bedded Carrizo sandstone at this locality. Though the locality was covered with detrital material so that a section was not practicable, sufficient information was obtained to show that the entire hill is composed of upper Carrizo sandstone. There were here found small concretions of limonite but very little evidence of cross-bedding. The strata are quite hard, massive, and evenly bedded.

In addition to these three principal localities described, there are a few in situ outliers of the Upper Carrizo, as indicated on the map; but these outliers are of little value except as they furnish additional information concerning the overlap. The most northern Carrizo outlier is located three miles southwest of Lacoste and about a mile south of the Cretaceous-Eöcene contact.

Over the remaining Eocene area to the north of the Wilcox-Carrizo contact the weathered material, sometimes in the nature of deep gray sand, and sometimes as boulders of various sizes, can occasionally be found. Such material probably represents an area over which the Carrizo has recently been in situ as an outlier but has lately been broken down to its present form.

South of the Wilcox-Carrizo contact two types of resultant Carrizo topography are in evidence. The basal part of the Carrizo which is surficially exposed, weathers to a type of topography and soil very similar to the Seco shale member of the Wilcox. However, the amount of crystal quartz and the greater amount of iron-bearing nodules in the basal Carrizo readily distinguish the soils of the basal Carrizo and the Wilcox formation. When in section, there is little trouble experienced in identification of the Wilcox-Carrizo contact. To the south in the area covered by the weathered material from the upper part of the Carrizo, a deep gray sand covers the ground and affords very few vertical sections. The purity of the sand and the regularity of its color, however, shows that it is derived almost in place from the underlying gray Carrizo sandstone. Toward the south county line the country becomes more level and most of the water courses are filled with unconsolidated sand. Along the contact between the iron-bearing Carrizo and the coarse gray Carrizo, hills of considerable height are common. These are undoubtedly capped by an indurated phase of the gray sandstone as a few fragments of this sandstone have been collected from the summit of the hills and upon one hill the gray sandstone is exposed over the entire hill. However, in most places, the deep coverings of Uvalde flint and caliche make it impossible to observe if the Carrizo lies beneath the alluvium.

This gray Carrizo sandstone in situ was not reported by Sellards from Bexar County, but the weathered product in the nature of "sand hills" was reported and mapped by him as the Carrizo. The iron-bearing horizon, if exposed in Bexar County, was probably included in the Wilcox. The demarcation between these two formations has never been definitely established but in Medina County there is sufficient change between the Seco shales of the Upper Wilcox and the coarse, quartz, iron-bearing sandstone of the overlying Carrizo to warrant a division.

As has been stated, the actual contact between the top of the Wilcox and the base of the Carrizo is undoubtedly concealed by younger overlapping Carrizo beds. Thus the uppermost Wilcox and the basal beds of the Carrizo are very probably not exposed at the surface. The entire thickness of the Carrizo in Medina County is probably between 200 and 250 feet.

PLIOCENE AND PLEISTOCENE

The Uvalde Formation

South of the Balcones Escarpment the hills and uplands are covered by non-marine deposits of the Uvalde formation. Originally this material was probably deposited by streams as alluvial or flood-plain sediments, and consisted of mechanically mixed detrital representing all of the older exposed formations to the north. In localities where it has been protected from extreme erosion, the formation consists of flint and limestone boulders embedded in a soft fine matrix of clay or silt. This phase undoubtedly more accurately represents the nature of the original deposit. On exposed surfaces the matrix is often washed away, leaving a residue of flint and limestone boulders varying in thickness from a few inches to ten or fifteen feet or more. The more argillaceous of the older formations which are exposed to the north, especially the upper part of the Austin, the Anacacho, and the Escondido, have very probably furnished the greater part of the matrix of the Uvalde formation. Farther to the south are added some fine sediments from the Wilcox formation of the Eocene. The limestone boulders in most instances are very hard and crystalline in appearance, and contain fossils of the Comanchean-Cretaceous. The flints, associated with the limestone boulders, vary in size from small pebbles to boulders over a foot in diameter. This flint is derived almost entirely from the Edwards limestone, as a number of boulders when broken were found to encase Edwards fossils. The Uvalde formation is more often noted to be a soft, yellow or grayish-white calcium carbonate matrix containing various sized pebbles and boulders of flint with some limestone fragments. The matrix is often stained by iron oxides or organic substances, and generally contains fibres and roots of plants. This form of the Uvalde is secondary. The original sediments consisting of a clay-silt matrix containing flint and limestone fragments, were laid down upon the various older, underlying calcareous formations. Later removal of the matrix in practically all places left a flint and limestone residue of pebbles and boulders lying directly upon the calcareous formations. The evaporation of waters containing mineral matter from the lower formations upon reaching the surface furnished the calcium carbonate which is the matrix of the greater part of the present Uvalde formation. The flint pebbles, even, when unconsolidated, are found to carry a coating of calcium carbonate. As would be expected, the size and amount of flint and limestone fragments increase toward the north, as the source of the material is approached. It is with difficulty that this caliche phase of the Uvalde formation is sometimes distinguished from the underlying Cretaceous and Eocene deposits. The presence of the flint, which is so abundant in numerous localities as to make the formation a flint conglomerate, and noticeable in all places, is generally sufficient to make the distinction possible. Their variety, frequency and position of occurrence clearly differentiate them from possible confusion with the indigenous flint of the Comanchean-Cretaceous. Toward the southern part of the country, where the flints are small and much less abundant, and the underlying Wilcox quite soft and marly, it is difficult to make the distinction.

As indicated on the map (Plate 9) the Uvalde formation covers a great part of the hills and uplands south of the Balcones Escarpment. Its actual areal extent is much greater than mapped, for whenever possible the underlying formations were mapped in preference to the Uvalde. If considered in their entirety, the Uvalde and Leona formations would practically cover the southern half of the county, or even a greater area, and such a map would be of little value.

In stream beds, arroyos, gullies, and other drainage features, the Uvalde formation is often cut through and the lower formations exposed. Wherever these exposures were sufficiently numerous and close together to indicate without doubt the presence of the formation under the entire area between exposures, the lower formations were mapped as continuous exposures, though covered locally by 10 to 20 feet of Uvalde.

The maximum thickness of the Uvalde could not be determined from surface exposures. It is extremely variable. In places only a few scattered fragments represent the formation, while in others, it forms vertical cliffs 15 to 20 feet high. In one place at the top of the ridge half a mile southeast of the Seco brick plant, a pit 15 feet deep did not penetrate the entire thickness of the Uvalde sediments. The Uvalde formation in Medina County is the equivalent of the same formation in Uvalde County, as described by Vaughan,[11] though Vaughan does not mention the caliche phase of the formation. It is also the equivalent of the Uvalde formation and Uvalde plain of Bexar County, described by Sellards,[12] and mapped as a Pleistocene high terrace.

The Uvalde formation is found as a flint or flint and caliche deposit varying in thickness from a mere veneer to thirty or forty feet, and capping the highlands especially of the Escondido and Eocene areas. Two chief localities can be described. The first locality includes the area between Castroville, Dunlay and Noonan; the second, a somewhat larger area west, southwest and south of D'Hanis, in the western part of Medina County. There are also more local deposits capping the Wilcox hills south of Hondo and the Wilcox and Carrizo hills in the vicinity of Round Pens. In numerous localities the Uvalde is composed of dark flint pebbles and boulders with a thin calcium carbonate coating on the outside. This coating is generally

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[11]Vaughan, T. W., Uvalde Folio, U. S. Geol. Surv.

[12]Sellards, E. H., Geology and Mineral Resources of Bexar County. Univ. Texas Bull. 1932.

stained a deep red from iron oxides. Frequently the iron also stains the underlying formation.

On the west bank of Seco Creek, two miles northwest of D'Hanis, 30 feet of Edwards flint embedded in a white caliche matrix comprise the Uvalde formation. A deposit of this type is found at the Escondido ridge southeast of the Seco Pressed Brick and Tile Company's plant at D'Hanis. A pit some eight feet deep has been sunk in the caliche and flint to obtain lime for plaster. Local deposits of the Uvalde can be found in practically all of the uplands in the south or southeast part of the county. In the southeast part of the county the Uvalde flint is practically absent.

PLEISTOCENE AND RECENT

The Leona Formation

South of the area underlain by the more resistant Comanchean and Upper Cretaceous rocks, the streams have in general wide valleys, with flood deposits representing material gathered from the older formations to the north. As practically the entire drainage of Medina County is from north to south, this alluvial formation varies in composition as successively younger strata are encountered.

In the northern portion of the county, the stream gradients are sufficient to afford little opportunity for deposition. The more resistant limestones are also less susceptible to the agencies of erosion than are the uppermost Cretaceous and Eocene formations farther south. Thus, north of the Balcones Escarpment, the streams have small valleys with little alluvium and the bed rock is generally exposed through the entire upper course of the streams. The softer marls and clays of the Escondido and Eocene-Wilcox furnish the majority of the material of the flood plains through the central part of the county. To this is added considerable flint from the Uvalde formation. The marls and clays mentioned weather to a heavy, black clay loam, which, mixed with flint and limestone boulders, forms the older terraces topographically below the Uvalde formation. In the immediate stream courses, the limestone fragments are greatly in excess, and the size and amount of these boulders decrease as the distance from their source in the older limestone formations increases. In the southern part of the county, sand from the Eocene replaces the boulders and in part the clay, so that the Leona would be more properly called a sandy loam.

No distinction in mapping has been attempted between any of the Pleistocene and Recent deposits. It is recognized that there are present two or three terraces of different age, but all deposits later than the Uvalde have been referred to the Leona. In numerous localities, also, a gradation from the Uvalde to the Leona is encountered and a differentiation is to a great extent arbitrary.

In Uvalde ounty, to the west, both the Uvalde and Leona formations have a typical development, and in this county they were first described. In Medina County both formations have probably as extensive a development, but whenever possible the underlying formations have been mapped in preference.

Deposits of the Leona formation are associated with the plains and areas contingent to the lower course of the drainage features of the county. The terraces and present forming deposits of the lower Medina River Valley in Medina County are excellent examples of this formation. The Leona is composed principally of about 100 feet of yellow, brown, flint-bearing clay loam. In some localities there are large deposits of gravel. Both loam and gravel, composed of fragments from all the formations to the north, are being deposited at the present time. The older terraces of late Pliocene and Pleistocene age show similar materials.

Along the lower course of Hondo River, Seco Creek, and in fact, all the other intermittent streams, there are greater or less accumulations of the Leona clay loam and gravel.

The principal deposit of the Leona formation not contingent upon large drainage features is the plain surrounding Hondo for about seven miles on all sides. Here the black clay loam ranges from a thin veneer to a depth of 15 feet or more, covering the Escondido. In the black soil are found fragments of limestone and flint from the Uvalde formation. At various other localities local deposits of the Leona formation are found. In mapping, both the Leona and the Uvalde have been overprinted upon the underlying geologic formations. Although these more recent deposits conceal the underlying formations to a great extent, it is possible in practically all places to ascertain the formation underlying the later Leona or Uvalde veneer.

Calcareous Concretions of the Leona Formation

Throughout the Leona formation, but especially in the lower and middle parts, there are found, chiefly associated with yellow clay, small concretions of calcium carbonate. These concretions are composed of practically pure calcium carbonate and are concentric in structure.

The origin of these concretions has been referred to an erratic form of caliche. Caliche is formed in semi-arid countries by water charged with calcium carbonate reaching the surface by capillary attraction and, through evaporation, depositing some of the lime in solution. The form of caliche, however, is laminated or platy and there apparently is no change of conditions during deposition which would result in the caliche assuming a concretionary form.

The theory that these concretions of calcium carbonate are formed by water ascending to the surface from the thermal springs has been advanced. These waters flowing underground for a distance in the limestone become filled with salts which are deposited when the waters lose some of their liquid content through evaporation. In both of these theories the origin of the calcium carbonate is sufficiently well explained. However, the concretionary form of the calcium carbonate deposits is erratic under either condition. Present day deposition of thermal springs so far as known does not develop a concretionary structure. The travertine deposits, which are practically pure calcium carbonate masses, and derived from thermal springs under conditions similar to those postulated in explanation of the calcium carbonate concretions of the Leona formation, are banded, laminated, or platy in structure.

The concretionary form of the calcium carbonate is not known in any caliche or thermal spring deposits.

Correlaton of the Strata Exposed in Medina County with the Strata Exposed in Bexar and Uvalde Counties

Along the various shore lines of the late Mesozoic and Cenozoic seas, which roughly paralleled the main Balcones fault on the south, there has been considerable lateral variation in the nature of the sediments deposited during the Upper Cretaceous and Eocene times, in the Rio Grande embayment.

The approximate easternmost extension of the north side of the Rio Grande embayment is in the vicinity of Bexar County, at which locality the main Balcones fault swings from southwest to west. From the north, the Balcones fault has a surface strike southwest along the western side of the Mississippi embayment to Bexar County; thence bearing to the west along the north side of the Rio Grande embayment, the fault strikes in general to the west with a decrease in the amount of throw till it becomes extinct in the Sierra del Burro of northern Mexico.

Westward from Bexar County to the western edge of the Rio Grande embayment, there is a rapid increase in the amount of sediments deposited and a corresponding variation in the nature of the deposits. Throughout the entire area, however, there is little change in the Comanchean strata. The principal variation in the Comanchean is the slightly increased thickness of the formations toward the west.

In a consideration of the lateral variation along the north side of the Rio Grande embayment especially in Bexar, Medina, and Uvalde counties, each formation will be considered separately and its variation from east to west noted. In this discussion the observation of the writer and any additional information from other authors will be included. Aside from the writer's field observations, the chief geologic works on the area are:

The Cretaceous-Eocene Contact in the Gulf Coastal Plain, by L. W. Stephenson.

The Geology and Mineral Recourses of Bexar County, by E. H. Sellards, which incorporates practically all previous reports on Bexar County.

The Uvalde Folio, by T. W. Vaughan.

Notes on the Rio Grande Embayment, by E. T. Dumble (Geol. Soc. Amer. Bull.).

Geological Survey of the Lands belonging to the New York and Texas Land Company, on the Upper Rio Grande Embayment in Texas, by J. A. Udden.

The Glenrose formation shows practically no lithologic changes from Bexar County, at least through Uvalde County. However, to the northwest from Uvalde to Crockett County there is a radical change. In Crockett County and probably in Val Verde and Sutton counties on the east and south, the Glenrose limestone is represented by the Basement sands of the Comanchean-Cretaceous, which are 250 feet thick. These Basement sands are very probably the western near-shore, time-equivalents of the Travis Peak and Glenrose formations to the southeast.

The Walnut clay and Comanche Peak limestone have not been mapped by Sellards, in Bexar County. However, as stated by Sellards, they are very probably present in Bexar County. In Medina County both the Walnut clay and the Comanche Peak limestone have been identified and mapped. Though exposed only in two localities they are clearly recognizable, the Walnut formation being a soft arenaceous clay full of *Exogyra texana*, while the Comanche Peak formation is a nodular limestone with very few *Exogyra texana*. In Uvalde County, Vaughan has mapped both formations together as Comanche Peak and assigned to them a thickness of 60 feet. This is approximately the thickness which they were found to have in Medina County. It is quite probable that the Walnut formation loses some of its clay and increases in the amount of contained lime toward the west, thus more nearly resembling the Comanche Peak limestone.

The Edwards limestone, though having no lithologic variation which could be detected in the area, has a slight increase in thickness to the west. As the Georgetown limestone has not been accurately separated from the underlying Edwards formation throughout the entire area, no observations could be made upon it regarding lateral change.

The Del Rio clay measures from 50 to 70 feet thick in Bexar County. In Medina County it is at least 60 feet thick and very probably will average nearer 70 feet. The clay increases in thickness and at the type locality in the vicinity of Del Rio is 100 feet thick. To the west there appears to be an increase in the amount of calcium carbonate and a decrease in kaolin. The fauna shows little variation from east to west.

In comparison with the more argillaceous formations, the Buda limestone shows practically no variation in texture or thickness from east to west. It is uniformly between 55 and 65 feet thick and has a smooth, or nodular, hard, dense, yellow-gray surface.

In Bexar County the Eagleford formation is a series of calcareous and arenaceous shales or flags, and is about 30 feet thick. In Medina County the thickness is about the same as in Bexar County, but the formation is considerably more calcareous and less sandy. In general the surface exposures resemble a chalky, or marly limestone and are distinguished with difficulty from the Austin chalk. To the west, however, the Eagleford more closely resembles its appearance in Bexar County. West of Uvalde County this formation rapidly increases and at the Rio Grande is approximately 200 feet thick. There is also a steady decrease in the amount of clay, especially in the upper part, and a corresponding increase in the lime content, west of Uvalde County.

The Austin chalk, like the other formations high in calcium carbonate, shows little variation, either in physical characters or thickness, from east to west from Bexar County through Uvalde County. However, on the Rio Grande it is at least 700 feet thick. Paleontologically there is also no noticeable change from east to west.

Above the Austin formation there is considerable lateral variation in the formations. In Bexar County the Taylor marl rests upon the Austin chalk with no intervening strata but although it could not be identified at the surface in Medina County, principally for the lack of good exposures, the Upson clay seems to extend as far east as the western line of Bexar County. In the MacClure test some three miles southeast of Dulay there are 20 feet of yellow clay lying between the Anacacho and the Austin formation, which very probably is the eastern extension of the Upson clays. The Upson clay is named from its characteristic locality near the Upson postoffice, in Maverick County. On fresh exposures it is a yellow-gray but soon turns yellow when exposed. Its characteristic fossil is *Exogyra ponderosa.* To the east it thins out under, and in the upper part is replaced by, the Anacacho limestone. The oyster *Exogyra ponderosa* which is characteristic of the Upson clay in part correlates it with the *Exogyra ponderosa* horizon of the basal Escondido in Medina County, and with the *Exogyra ponderosa*-bearing Taylor marls of Bexar County. In all probability the Anacacho limestone is a large lens making a physical and faunal break between the Upson clay and the remainder of its contemporaneous deposits—the basal Escondido. *Exogyra ponderosa* is also found in the basal and upper parts of the material referred to the Anacacho limestone by Vaughan, in Uvalde County. In these marly parts of this formation, conditions were probably very nearly similar to those existing during Upson clay deposition in Maverick County. The entire material in Uvalde County from the top of the Austin chalk to the base of the Pulliam formation, all of which has been referred to the Anacacho by Vaughan; the material in Medina County from the base of the Upson clay on the top of the Austin chalk to 100 feet above the base of the Escondido, which is referred by the writer to the Upson and the Anacacho and Escondido formations; and the entire Taylor formation of Sellards in Bexar County, were deposited contemporaneously as evinced by the common presence of *Exogyra ponderosa.* The lithologic variation in the formations, however, shows that deposition occurred under varying physical conditions. These formations described are correlated as contemporaneous.

deposits on fossil evidence, but are locally differentiated in various manners as necessitated by lateral variation in conditions of deposition.

The Anacacho limestone has been identified as such, entirely across Medina County. It is approximately equivalent to the basal two-thirds of the Taylor formation of Bexar County. On account of the rapid physical changes which the Anacacho formation undergoes from west to east across Uvalde and Medina counties, it is impossible to identify the Anacacho as such in Bexar County, at the surface. However, a drill core from the Somerset oil field in Atascosa County quite evidently penetrates the true Anacacho limestone.

From east to west across Medina County the Anacacho changes from a sandy marl with local asphalt-bearing limestone phases resembling the true organic-fragmental Anacacho, to an organic-fragmental limestone. West of Medina County the formation increases in thickness till at the west side of the Anacacho Mountains in Kinney County, it is 400 feet thick. In Medina County the Anacacho is approximately 200 feet thick.

Under the description of the Anacacho and Escondido formations, the reason for the limitations of these formations is given. The chief reason is because of the abrupt physical break at the top of the asphalt-bearing limestone. Paleontologically, however, the Taylor formation of Bexar County includes all the Upson clay in Medina County, all of the Anacacho limestone, and the basal 100 feet of the Escondido lying below the top of the *Exogyra ponderosa* horizon. The Taylor formation of Bexar County also correlates with what is referred to by Vaughan as the Anacacho formation in Uvalde County; with the Anacacho and Upson clay of eastern Maverick County; and with the Upson clay of western Maverick County, the Anacacho lensing out in the eastern part of Maverick County and its equivalent being the upper part of the Upson clay of that area. The Anacacho formation is clearly a submerged bar formed under nearshore conditions and, although formed at the same time as the lower Taylor formation in Bexar County, because of peculiar local conditions of deposition has resulted in a massive organic limestone lens lying in the Upson clays. It is physically very different from the adjacent contemporary deposits, yet was laid down at the same time, as evinced by the paleontologic data. *Exogyra ponderosa*, which is considered to be the characteristic fossil for the Taylor marl in Bexar County, consequently is used to designate the limits of equivalent formations in Medina County, and the equivalent formations to the west. Through the radical physical change, this fossil persists; and in a recurrence of normal conditions as found in the base of the Escondido formation in Medina County, this fossil continued its existence contemporaneously with the other members of the species in Bexar County. The upper limit of this fossil, marking the upper limit of the Taylor formation in Bexar County, likewise marks the top of the corresponding formation in Medina County, notwithstanding the intervening physical change in the nature of the Anacacho limestone. Also the *Gryphea vesicularis* horizon assigned by Sellards and by Stephenson to the upper Taylor is placed in Medina County 10 feet above the base of the Escondido. Thus both of these paleontologic horizons together with the additional data make an accurate correlation between the Taylor and Navarro formations of Bexar County and the Anacacho and Escondido of Medina County. Likewise *Exogyra ponderosa* in the Upson clay both west of the Anacacho Mountains and in its eastern extension under the Anacacho formation as well as in the basal Escondido, shows that these clays practically include the Anacacho limestone lens, and with it, are the equivalent of the Taylor formation of Bexar County.

In the Escondido formation in Medina County there is included all the material lying above the organic-fragmental limestone carrying asphalt; and below the Elstone glauconitic limestone of Eocene-Midway age. It includes all of the Navarro formation of Bexar County, and in addition, higher Cretaceous strata which are not present in Bexar County. The parallel erosional unconformity in Bexar County between the Cretaceous and the Eocene is in part represented by the higher Cretaceous strata. Thus while there was non-deposition or erosion along the eastern half of the north side of the Rio Grande embayment, there was deposition along the west half of the north side, as is evinced by the rapid increase of the Upper Cretaceous to the west and the presence of higher Cretaceous strata in the same area. Thus in Medina County the highest Escondido present is represented by a part of the Cretaceous-Eocene unconformity in Bexar County. So toward the west there is less of a time interval between the latest Cretaceous and the earliest Eocene deposits and a corresponding increase in the thickness of the Upper Cretaceous sediments. In the upper Rio Grande embayment the San Miguel beds and the Coal Series, totaling some 800 feet of Cretaceous sediments, form a lens between the Upson clay and the Escondido. At the same time there is also higher Cretaceous than the Escondido of Medina County present in the region to the west. Although it is impossible to determine accurately, the Pulliam formation, of Vaughan, probably correlates with the Escondido in Medina County; and as explained by Vaughan, the small amount of this formation shown in vertical section is very probably due to concealment through overlapping of subsequent Eocene formations.

The *Ostrea cortex* horizon identified by Vaughan in Uvalde County and placed by him at the top of the Pulliam, is the same horizon of *Ostrea cortex* identified in Medina County above the *Sphenodiscus pleurisepta* horizon at Rock Crossing, and placed at the top of the Escondido. Vaughan states that at most there are less than 200 feet of Pulliam visible between the Anacacho limestone and the *Ostrea cortex* horizon, while in Medina County there are 700 feet between the *Ostrea cortex* horizon and the Anacacho. This small amount of exposed Pulliam in Uvalde County is very probably due to concealment by the overlapping Wilcox. Undoubtedly the Escondido of Medina County and the Pulliam of Uvalde County are equivalents and would be practically the same thickness if all of the Pulliam were measured.

Of the Eocene strata, the Midway, the Wilcox and the

Carrizo of Bexar County are undoubtedly the exact equivalents of the Midway, Wilcox and Carrizo, respectively, of Medina County; and, collectively, of the Myrick of Uvalde County. Though there is considerable lateral variation in the Midway between Bexar and Medina County and across Medina County, and no exposure of the Midway east of Noonan in Medina County because of the overlapping Wilcox, the boundaries between the groups remain constant and are readily identified from paleontologic as well as physical criteria. In eastern Medina and Bexar County there is only a limited amount of the Uvalde formation as compared with the amount of this formation in Western Medina and Uvalde counties. In general it can be stated that there is an increase in the thickness as well as in the amount of lime in the formations from east to west, up the Rio Grande embayment.

IGNEOUS ROCKS

Igneous rocks in situ are known to be exposed in only three localities in Medina County. The nature of these intrusions is slightly different for each locality. In addition to the igneous material in situ, pebbles and small basalt boulders were collected from both Little Seco and Big Seco creeks, in the northwestern part of the county. At the junction of Little Seco Creek with Big Seco Creek at the Nixon ranch-house, small basalt pebbles were collected. An examination of the gravel deposits of Little Seco immediately before its junction with Big Seco afforded a greater number of igneous pebbles. Since Little Seco Creek drains considerable area of the northwestern part of Medina County, the igneous material present in the drainage area of that creek would be indicated in the wash in the creek bed. Proximity to an intrusion would result in larger and more numerous boulders. The entire length of Little Seco Creek in Medina County was examined and the wash in the creek bed showed a gradual increase in size and number of boulders. As there are no localities in the creek bed in Medina County where the igneous boulders are abnormally large or more common, and no igneous rocks were found at any place in the drainage area of Little Seco Creek, it is quite probable that in Medina County there are no igneous rocks in situ in the area drained by Little Seco Creek. So far as known, all the igneous material in Little Seco Creek is washed from Uvalde County, or counties farther to the northwest.

In Big Seco Creek, though the float shows much less igneous rock than the deposits in the bed of Little Seco Creek, there are no indications that any igneous material is present in situ in any of the area of Medina County drained by Big Seco Creek. The pebbles are much smaller and less common in Big Seco than in Little Secro Creek. The igneous pebbles in the wash of Big Seco Creek evidently come from Bandera or other counties to the north and east.

As the Seco creeks drain practically the entire northwestern part of the county, it is very probable that there are no igneous rocks in this area. The increase in igneous pebbles in Little Seco over the amount in Big Seco Creek, shows that the main igneous bodies lie to the west and northwest of the northwestern part of Medina County.

One-half mile south of the Mumme Ranch, about 12 miles due north of Hondo, an igneous instrusion one-eighth mile in diameter is found in the Edwards limestone. The material contains a little feldspar which can be recognized with a lens. The rock is a very dark gray or black, hard, fine-grained basalt, with feldspar showing as light gray or white specks; numerous dark glassy crystals of hornblende or augite; and many dark yellow specks which probably are weathered magnetite. Some minute cavities are filled with this dark yellow substance, which is evidently a weathered product, probably magnetite, with possibly some crystals of olivine. The rock is very uniform in color, hardness and texture. Its fracture is typically that of trap rock. It is very hard and the unweathered edges readily cut glass. On unweathered surfaces it is uniformly very dark gray to black, and weathers to a rusty deep or reddish brown. The presence of iron is probably chiefly accountable for these weathered colors. The entire igneous material can most probably be referred to the plagioclase-basalt group, though it is possible that there is a considerable amount of nepheline basalt.

At the contact between the igneous intrusion and the surrounding Edwards limestone, considerable contact metamorphism has occurred. The uniformly gray-white Edwards limestone has been baked to a dark brown and considerably hardened. Deposition of iron has taken place in the cavities of the Edwards limestone adjacent to the igneous material. Some of these enrichments have filled cavities a foot in diameter.

It is very probable that the igneous material reached practically no higher elevation than the one which it now occupies. Had it penetrated a greater amount of the Edwards limestone, its greater hardness would have enabled it to withstand erosion better than the Edwards limestone and the rock would remain as an igneous neck or boss considerably higher than the surrounding territory. The intrusion occupies a low place beside an intermittent creek in a broad valley. On all sides the Edwards limestone is at a much higher elevation. A hundred feet to the east of the intrusion, the Edwards limestone is some 20 feet higher than the top of the igneous rock. It is quite evident that the igneous intrusion has never reached a much greater elevation than the one which it now occupies, and that its exposure to the surface has come through the erosion of the surrounding limestone, which at present is sufficiently great to uncover the top and one side of the intrusion. The small creek located at the west side of the intrusion is accountable for the exposure of that side of the igneous mass while the east side still remains covered.

The nature of the material itself precludes surface conditions during cooling. Cellular glassy structure would have resulted from quick surface cooling. Deep slow cooling would have produced much larger and better developed crystals. The texture of the rock with some small crystals shows that it cooled quite rapidly, yet slowly enough to permit a slight mineral segregation. An estimate would place the top of the rock some 500 feet below the surface at the time of its intrusion.

No commercial deposits of any metals could be found and it is quite improbable that any are present in economic quantities.

On Cow Creek, one mile above its junction with the middle Verde Creek, two miles south of the King ranch-house and 16 miles north of Hondo, is an igneous dike 15 feet wide and one-fourth mile long. The igneous material occupies the position of a fault which has a surface trend of N 60° E, roughly parallel to the remainder of the faulting in the county.

Two distinct types of material are present in this intrusion. The great majority of the rock is identical with the igneous boss one-half mile south of the Mumme Ranch. The material is a deep gray to black, fine-grained basalt rock, with specks of feldspar. The black crystals are probably hornblende or augite with some magnetite. The magnetite affords the extra weight of the rock and its weathered form probably gives the softer brownish yellow crystals which fill the cavities. The rock has a very angular fracture and is harder than glass.

On exposed surfaces the black basalt weathered to a deep reddish brown.

Associated with the hard black basaltic rock and lying between it and the metamorphosed Glenrose limestone, is considerable chocolate and dark green-colored clayey material cut by calcite veins. The deep red and chocolate colored clay is evidently a more weathered product of the green material, for underneath the red weathered surface the green clay is found. The iron present in the basalt possibly affords the red coloring to the weathered clay.

The entire clay material lying between the hard black basaltic rock and the metamorphosed Glenrose limestone very much resembles a decomposed phonolite. It is not altogether different from a serpentine, resembling chlorite. It is in all probability an amygdaloidal material—a contact facies which occurs between an igneous intrusion and a soft calcareous rock. The escape of heated gases at the time of the intrusion from the igneous magma into the soft porous limestone adjacent, metamorphosed the limestone and produced a somewhat rotten and altered phase of the igneous rock near the contact. This amygdaloidal material is not confined to any one class of rocks but when conditions are favorable, is formed between an igneous rock intruding a soft calcareous strata. No amygdaloidal material was found at the contact between the igneous rock and the Edwards limestone half a mile south of the Mumme Ranch. The hardness of the Edwards limestone is the chief reason for its absence at the last locality mentioned.

The dike on the King Ranch like the boss near the Mumme Ranch, probably reached practically no higher elevation than the one at which it now stands. The exposure, like the neck near Mumme Ranch, has been effected by the weathering of the surrounding softer limestone. Cow Creek, flowing past the dike on the north, has exposed some 30 feet of the igneous rock on the south bank of the creek. On the south of the dike, the sedimentary rocks occupy a higher position than the top of the dike. If the dike had reached a higher elevation in the Glenrose limestone, it would be much more prominent, since it is much more resistant than the surrounding Glenrose limestone. As it is, the softer limestone occupies all the higher elevations except on the north of the dike, where it has been eroded by the stream, and it is evident that the position of the creek and of the surrounding features is entirely responsible for the exposure of the dike. The physical nature of the rock shows that it was formed under conditions very similar to those producing the neck near Mumme Ranch.

A spring rises to the surface from the fault at the north side of the dike and flows into Cow Creek. The dike, in intruding the Glenrose formation, has cut through a water-bearing horizon, and since the igneous rock is practically impervious, it has afforded an impediment to the water which, under hydrostatic pressure, rises to the surface.

A shaft has been sunk some 90 feet in the Glenrose limestone at the contact between the limestone and the dike. Throughout its entire depth, no igneous material was encountered. Since the shaft is to the south of the fault and the downthrow of the fault to the south, and as no igneous material was encountered, it is quite evident that the dike has ascended nearly vertically along a fault plane and that from the main dike mass there probably are no lateral extensions into the Glenrose limestone. Although the shaft is located in the zone in which enrichment should occur by the introduction of the magma, with the accompanying gases and vapors, no commercial mineral deposits were encouneered.

At the northern county line of Medina County, two miles west of the King ranch-house, there is an igneous neck exposed at the surface through the erosion of the surrounding Glenrose limestone. The conditions of occurrence of this igneous intrusion are undoubtedly very similar to those discussed under the intrusion near the Mumme ranch-house. The material of both intrusions is identical. In both places the adjoining sedimentary rock has been turned to a deep brown by heat and perhaps chemical action, generated by the igneous intrusion. From all evidence the intrusion west of the King Ranch has never occupied a position of much higher elevation than the elevation at which it is now found. Only through recent erosion of the Glenrose limestone has the igneous rock been exposed at the surface. Observations of actual exposures show that all igneous rocks in Medina County are of the intruded mode of occurrence. Of this intrusive group, there are two classes: (1) bosses, stocks and necks, such as the intrusion half a mile south of the Mumme Ranch and the intrusion at the north line of Medina County, two miles west of the King ranch-house; and (2) dikes, such as the basalt dike on Cow Creek.

In a deep gulley about eleven miles south slightly west of D'Hanis, a basalt stratum two and one-half feet thick has been reported. It is very probably present, but it could not be found during the present survey. So far as known this is the only laccolithic or laterally intruded sheet of igneous rock reported from surface exposures in Medina County. No other surface flows of igneous rocks are known in the county, though in the Elstone structure in the south-central part of the county, it is very probable that there is a laccolith some 700 to 900 feet below the surface.

STRUCTURAL GEOLOGY

All the formations of the Cretaceous and Eocene in Medina County in general dip east of south toward the Gulf Coast. In various parts of the county, however, the general dip is modified by local structural conditions. The chief factor affording a diversion from the normal dip is the main fault of the Balcones fault zone. North of the main Balcones Fault which is marked topographically and physiographically by the Balcones Escarpment, extending approximately east and west across the north end of the county, and geologically by the contact between the Glenrose and Edwards formations, the dip increases from five feet to the mile in the extreme northern part of the county, to 100 feet per mile immediately north of the escarpment. Aside from this main disturbance, various local structural features in the Glenrose area to the north modify the direction and rate of dip.

South of the Balcones Escarpment structural conditions are much more complicated. The downthrow side of practically all of the faults in Medina County is toward the south and southeast. Similarly the longer axis of the folds is in general east and west or north of east and south of west, roughly parallel to the surface strike of the faults, while the longer and gentler flexure is to the south or southeast. Locally some faults are suspected to pass into folds, which flatten out and are the terminations of the distributed areas. The result of practically all the disturbances in the county is to place the formations at a lower level or an increased depth, toward the Gulf Coast.

In general, the strike of the faults at the surface and the longer axes of the folds are roughly parallel to the main Balcones Fault. In the eastern part of the county on the structures in addition to the dip of the formations as mentioned, there is a plunge of the formations in a west or south of west direction. This plunge of the formations has not been found west of the Hondo River.

The structural features of the county are likewise indicated on the geologic map. Faulting is indicated by a single line at the location of the various main faults. In addition there are numerous small faults which it is impracticable to show on a map of this nature. The remaining chief structural features in the nature of folds are shown in their proper positions by the usual reconnaissance symbols. The information concerning these folds should be considered as accurate reconnaissance. The location and the nature of these folds are accurately described, though not in the detail which should accompany a detailed transit or plane table and stadia survey.

The only subsurface data in the county are afforded by a few water wells and tests for petroleum. These data, though valuable in giving the thickness and subsurface nature of the various formations at their respective localities, afford practically no structural information.

The data afforded by these subsurface explorations are attached at the end of the report under the heading of Subsurface Data.

FAULTING

Although some small faults with a throw of less than 50 feet are found in the Glenrose area in the northern part of Medina County, the main fault of the Balcones zone enters the county on the east, eight miles south of the Bandera-Medina County line, and bending toward the north, leaves the county at the western side, seven miles south of Bandera County. Throughout this area, with one exception, the Edwards limestone on the south side of the fault is downthrown against the Glenrose formation to the north. The area of exception is where the main Balcones Fault crosses Hondo River, 18 miles west of north from Hondo and one mile below the Rothe Ranch. At this locality the Walnut and Comanche Peak formations are found in the drag of the fault where they have been protected from erosion.

The Balcones fault zone across Medina County is a complicated system of block faulting. In the eastern part of the county, the displacement is greater than in the west. Two main lines of faulting, in general, compose the Balcones fault zone. On the north, the zone is bounded by a line of simple slip-faulting, while on the south side, east of the Medina River, there is a double fault line. West of the Medina River on the south side of the fault zone, the faulting rapidly decreases to the west, both in the number of faults and the amount of throw. Between the two main lines of faulting on the north and south sides of the zone, there is a series of cross faults, originating at the junction of the fault segments which compose the main Balcones Fault, and extending to the line of faulting on the south of the fault zone. Between these main faults, there are many small faults with a surface strike approximately parallel to the main lines of northeast and southwest faulting. West of Seco Creek no faulting was found south of the main Balcones fault.

On San Geronimo Creek, two and one-half miles north of Cliff, in the northeastern part of Medina County, the main fault of the Balcones zone enters the eastern part of the county. At this point the throw is approximately 600 feet. The main Balcones Fault is not a single curved fault line, but a series of segments, the individual faults of which, though intimately related in origin and character, have each a distinct surface strike. Four main segments have been identified in the main Balcones Fault, and it is highly probable that upon more detailed work these main segments will be found divisible into smaller and more complex components.

From the point mentioned on the San Geronimo Creek, two and one-half miles north of Cliff, the main fault trends slightly south of west, intersecting the Medina River two and one-half miles above the main irrigation dam. The fault is quite evidently responsible for the change in the course of the river in this vicinity, from south to east. A probable projection of the first cross fault, in the northeastern part of the county, is responsible for the extension to the north for about two and one-half miles of the Edwards limestone on the west side of Medina River. The course of the Medina River in this vicinity approximates the trend of this cross fault.

At the point of confluence of the waters of Indian Spring, Moccasin Spring and Cypress Creek, with the Medina River, the second segment of the fault trends slightly south of west, practically parallel to the first segment. The course of Indian Spring is in the Glenrose limestone at the foot wall of the fault, and the water flows almost due east in the fault to the Medina River. Moccasin Spring, rising in the Edwards limestone about a mile south of the fault, flows northeast till it encounters the fault and then, joining the water from Indian Spring, flows due east to Medina River. Cypress Creek, originating in the Glenrose formation three miles north of the fault, flows southeast conformably to the general drainage of the county, till it reaches the fault and encounters the massive Edwards limestone on the south. It then follows along the fault with the waters from Indian and Moccasin Springs to the Medina River.

On the north side of the canyon, which is about 200 feet deep, the soft yellow fossiliferous Glenrose limestone is found, while on the south side are the massive, poorly fossiliferous, hard, slate-gray, flint-bearing strata of the Edwards limestone. The canyon varies from one-eighth to one-fourth mile in width. At this locality the displacement was calculated to be between 500 and 600 feet.

Three miles south of the Medina-Bandera county line on the Bandera road the main Balcones Fault is again readily observed in the creek bed at the road crossing. East Verde Creek, flowing south, enters the fault and follows east along it for a quarter of a mile before it cuts through the Edwards limestone to the south. Along the ranch road leaving the Bandera road in the vicinity of this crossing and leading east to Indian Spring, the main Balcones Fault is observed. In all places of this region, the Edwards was found to be faulted against the Glenrose with no remnant of the Walnut and Comanche Peak formations showing.

Three-quarters of a mile west of East Verde Creek, the main Balcones Fault strikes practically parallel with the segment east of East Verde Creek. However, the faults lie half a mile farther to the north and correspondingly the

Edwards limestone extends half a mile north of its position to the east of East Verde Creek. At this point a projection of a cross fault determined at the surface some eight miles southeast intersects the main Balcones Fault.

The location of the eastern end of the third segment of the main Balcones Fault which lies half a mile north of the west end of the second segment of the same fault, is on the ranch road to Bandera one and one-fourth miles below the junction of Middle and West Verde creeks. From this point, the strike of the main fault on the surface is slightly south of west. This bearing is held until one and one-fourth miles west of Hondo River. The fault crosses the Hondo River one mile south of the Rothe Ranch, 18 miles west of north from Hondo. This region is the only locality along the main fault at which the intervening Walnut clay and Comanche Peak limestone, lying between the Glenrose and Edwards formations, were found. Probably because of a smaller throw and a greater heave, a larger angle of hade is formed, so that in the fault there is considerable drag. As the downthrown side of the fault is to the south, the drag, if sufficiently great, would expose the formations for some distance below the base of the Edwards limestone. The Walnut clay and Comanche Peak formations are highly tilted to the south and pass under the Edwards limestone on the south side of the fault. It is very probable that there is about 500 feet displacement in the main fault at this place.

The small area occupying the middle part of the fault segment lying between East Verde Creek and the Hondo River, because of the nature of the country, was not examined as carefully as is desired. It is highly probable that the fault line of this segment is not a single tangent, but that there is a slight change in direction of strike where the third cross fault, noted on the surface three miles northwest of Quihi and projected through the igneous neck half a mile south of the Mumme Ranch, if extended, would intersect the main Balcones Fault. There is, however, little deviation from the direction of the main fault, as shown, since all but a very small area has been examined.

Additional data showing the intimate association of the igneous intrusion in Medina County with the block faulting as determined from surface observations, are afforded by the third cross fault which is first noted on the south side, northwest of Quihi and which was traced on the surface for five miles in a N 26° W direction. A projection of this fault on the same bearing observed on the surface intersects the igneous boss half a mile south of the Mumme Ranch. The position of this igneous intrusion without doubt was determined by the location of the cross fault just described, at this locality. The molten magma ascended along the fault plane as a line of least resistance. No faulting parallel to the Balcones Escarpment could be found at this point.

The first radical change in the course of the main Balcones Fault from a bearing slightly south of west begins one and one-fourth miles west of Hondo River. The fifth segment of the main fault bears S 70° W and leaves the county two and one-tenth miles above the Nixon Ranch. North of the Nixon Ranch the fault is readily identified and there is at this locality probably a less vertical displacement than at any other locality in Medina County. The main fault as well as the compound line of faulting on the south of the Balcones zone shows considerably less throw in the western part of Medina County than in the eastern part. This change of direction in the bearing of the last segment of the main fault practically parallels it with the strike of the outcrops of the Eocene formations which turn rapidly to the south in western Medina County. It, however, does not explain the northwest bearing, in the western part of the county, of the Cretaceous formations overlying the Edwards limestone.

East of the Medina River the southern limit of the Balcones fault zone is marked by two parallel faults bearing 67° west. With the exception of the fault in the second segment along the lower side of the Balcones fault zone, all the faulting in the lower part of the Balcones fault zone is practically parallel. The two faults east of the Medina River at the lower part of the Balcones fault zone, terminating immediately west of the Medina River in a cross fault bearing N 30° W, form the first or eastern fault block in Medina County. Along the northern one of the two faults just mentioned, the Georgetown-Edwards is in contact with the Austin chalk. The intermediate formations, namely, the Del Rio, Buda, and Eagleford, are faulted below the surface. There is then represented a throw of at least 175 feet. The fault is a normal slip fault with the downthrow to the southeast. The location of this fault is very readily detected at the surface. Three-quarters of a mile north of Cliff on the San Geronimo Creek, the Georgetown-Edwards formation is found on the north side of the creek, while the 60-foot bluff on the south side is Austin chalk. The creek at this locality flows for half a mile on the fault.

Again on the road between Cliff and the main irrigation dam the main Balcones fault crosses the road half a mile northwest of the toll gate. Its location at this point is marked by a prominent southeast-facing escarpment of Georgetown-Edwards limestone which overlooks a flat Austin plain. Halfway between the diversion dam and the bridge over the Medina River, half a mile east of Red Wing, the fault can be accurately located. At this locality the massive bluffs of Georgetown-Edwards limestone on the north side of the fault are in contact with the soft, yellow, fossiliferous Austin chalk on the south. The most southern fault of the first fault block is parallel to the one just described. The vertical displacement aggregates at least 250 feet, since the entire Anacacho limestone is missing from the surface exposures and the Austin chalk is in contact with the Escondido. The downthrown side of this fault is likewise to the south.

Terminating the first fault block on the east and demarking it from the second block is a cross fault bearing N 30° W. From south to north on the west side of the fault the Buda limestone, the Del Rio clay and the Georgetown limestone abutt against the Escondido on the west side of the fault, while the Edwards limestone on the west side of the fault is in contact in turn with the Austin chalk, the Edwards limestone and the Glenrose limestone on the eastern side. Such conditions indicate that in addition to the faulting within the respective blocks themselves, the first fault block has been relatively depressed and the second block elevated and flattened, thus giving a northward extension to the younger formations in the first block and a southern extension of the older formations in the second block. It is also quite evident that there has been a flattening in the inclination to the south in the second block, giving a greater surface exposure to the Edwards limestone. The narrow exposure of Del Rio, in comparison to its wide exposure in the adjoining block to the west, may be due to an extension of the faulting in the first block across into the second block. This could not be detected at the surface. There is, however, a thin veneer of Buda on the northern part of the area mapped as the Buda formation. As is indicated, the Del Rio clay can be seen in gullies which have been cut through the Buda limestone.

At the southern limit of the Balcones fault zone on the second block there is a single fault with a throw of approximately 550 feet. Along the south side of this block the Buda limestone is seen in contact with the Escondido formation. The second cross fault bounding the second fault block on the west and the third block on the east, has a bearing of N 25° W.

On the eastern side of the fault from south to north the Buda limestone is in contact with the Austin chalk, the Eagleford shales and the upper half of the Buda on the west. The Del Rio clay on the east side is in contact with the Buda on the west, while the Georgetown-Edwards and the Glenrose on the east side are in contact with the lower Buda, the Del Rio and the Edwards on the west side. The Glenrose on the east is faulted against the Edwards to the west of the fault. There has evidently been a flattening of the third fault block giving an abnormal Del Rio and Buda surface exposure. It is not improbable that there is a cross fault along the northern limit of the Del Rio clay, though none could be found. The presence of an abnormal surface exposure of the Buda in the third fault block, as indicated on the map, when the formation is only 60 feet thick, together with the outlines of Buda in the Del Rio area and the inliers of Del Rio in the Buda area, indicates that the dip is practically zero. Along the south side of the third fault block the Escondido and the Austin formations are in contact while the Anacacho is eliminated through faulting. The trend of this fault, which is along the southern side of the Balcones fault zone, is S 65° W.

Terminating the third fault block on the west is a cross fault parallel in strike to the cross fault on the eastern side of the same block. On the east side of the fault, at the west of the third fault block, the Austin, Eagleford and Buda formations are in contact with the Escondido, Austin, Eagleford, Buda, and the upper half of the Del Rio formations on the west side of the fault. The Del Rio on the east of the fault is in contact with the lower half of the Del Rio and the Georgetown on the west.

In addition to the main fault at the south end of the fourth fault block, there are two small faults in the Buda limestone. These smaller faults are parallel to the main fault, and have the downthrow on the south side. The southern fault has a throw of 50 feet and the northern one about 10 feet, this latter affording a view of the Del Rio clay underlying the Buda in the base of the foot wall of the fault.

Along the western end of the main fault on the south of the fourth fault block, the Austin formation is in contact with the Escondido; in the vicinity of Hondo River the Austin is in contact with the Anacacho on the south while in the eastern half, the Austin is again in contact with the Escondido and the Anacacho formation is missing. There is represented at least a 200 foot vertical displacement in the eastern half of this fault block while on the western part it is very little over 100 feet. In the western part the *Gryphea aucella* horizon of the Upper Middle Austin is in contact with the *Gryphea vesicularis* horizon of the Escondido which is 10 feet above the base of the Escondido. Erosion and slight minor faulting have exposed the Anacacho in the bed of Hondo River and over the limited area to the east. The extreme width of the Buda surficial area, the Del Rio clay in the river bed showing through the Del Rio over practically the entire Buda area, and the rapid decrease in surface area of the Buda to the east, indicate an elevation and a flattening of the western part of the block. The narrowing of the Austin area on the west is dependent chiefly upon the two smaller faults just described.

Along the east side of fault block number five, the Anacacho limestone is in contact with the Austin, the Eagleford and the upper half of the Buda limestone, while the Austin, the Eagleford, the Buda, and the Del Rio are faulted against the Buda, the Del Rio, and the upper part of the Georgetown on the east.

West of the Hondo River the formations come in contact in normal sequence, though there is a small fault between the Anacacho and the Escondido on Seco Creek two miles north of D'Hanis and some smaller faults on the Anacacho area to the north.

In general, then, it may be concluded that both the cross faulting and the main faulting along the south of the Balcones fault zone rapidly decrease to the west, leaving the formations in normal sequence at the western county line. The decrease in 36 miles from nearly 500 feet of displacement by faulting to practically zero in the main east-west faulting, and a corresponding decrease in the cross faulting, show an extensive cessation of tectonic activity in the region toward the west. The main Balcones Fault also shows a decrease in the amount of throw in passing from east to west across Medina County.

STRUCTURES

Aside from the fault blocks which have just been described and in addition to the small structures in the northern part of Medina County, there are a few structural folds, which are readily recognized at the surface. As there are practically no sub-surface data on these localities, all observations are confined to surface indications. With the exception of the first structure described, all of the others which are identified have an economic significance in that they quite probably contain petroleum in commercial quantities.

In the northern part of the county the structures have practically no economic value and since small structures are numerous, only the largest fault blocks and the one large structure are described. In the southern part of the county all structures which were identified and considered large enough to be of economic importance are discussed. Much more detailed information is desired to give more accurate data about these folds, but as there are no well records and the surface of the ground is covered in most places by alluvium, the data given are all that are available.

The Culebra Structure

The Culebra structure first named and described by Sellards[13] in Bexar County, "Is a relatively broad structure, the axis of which lies some six miles south of the Balcones Escarpment." . . . "On the crest of this structure in the western part of the county the Austin formation lies at the surface, while both to the north and south the Taylor formation lies at the surface."

At the eastern line of Medina County the structure is approximately seven miles in width. The axis of the structure enters Medina County about one mile north of the Portranco Road, and extends through Loma Alta to Rio Medina. In Medina County the Culebra structure consists of a core of Austin chalk around which, on the north, west and south in succession away from the axis of the structure, are the Anacacho and the Escondido formations. The plunge south of west which was observed by Sellards to occur in Bexar County increases to the west and five miles west of the Medina-Bexar county line, carries the structure below the surface, where it flattens out into a normal southward dip. As stated, the Anacacho and Escondido formations occur in normal sequence around the Austin chalk core. The presence of the structure at this locality is undoubtedly accountable for the northward extension of the Escondido. To the north of the Austin chalk core are encountered suc-

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[13]Sellards, E. H., Geology and Mineral Resources of Bexar County. Univ. Texas Bull. 1932, p. 83.

cessively the Anacacho and the Escondido formations, the latter at its northern edge being faulted against the Austin chalk. Although the contact on this structure between the Austin chalk and the Anacacho limestone is obscured in places, the structure is definitely located by the positions of the Anacacho and the Escondido formations and the contact as here established between these two formations. In addition the positive identification of the *Gryphea vesicularis* horizon, at the base of the Escondido, extending in a semi-circle from one mile south of Cliff southwest of Rio Medina and around the southwestern point of the structure to a locality on the Military Highway one and one-half miles east of the Medina-Bexar county line, definitely indicates the Culebra structure. The *Gryphea vesicularis* horizon definitely establishes an elevation or key horizon in the Escondido 10 feet above the base of the Escondido formation from Cliff on the north, southwest of Rio Medina, and thence south of east into Bexar County. The width of the structure is seen to narrow rapidly to the west. At its western edge it flattens out and the Escondido has its normal dip to the southeast.

The Elstone Structure

The structure immediately southeast of Elstone is one of the most definitely marked structures in the southern half of Medina County. It is likewise considered to be connected with a line of weakness or folding which extends west from the Mission and Alta Vista fields in Bexar County, practically west with the strike of the Upper Cretaceous and Eocene formations, through the structure at the Haass well one mile northwest of Noonan to at least as far west as Elstone. In accordance with the remainder of the folding and faulting in Medina County, the axis of the Elstone structure is in a general east and west direction. From the size, shape and structural relation of the Elstone dome, there is a strong possibility that this structure is of igneous origin. Molten magma intruded into the underlying formation at a point of fracture along the general line of weakness, as described, would give results practically identical with those observed. The amount of the vertical displacement in the overlying formation, in comparison to the size of the structure, makes the igneous origin of the structure more plausible.

Except in the bed of the Hondo River, observations for dips are impossible but, as shown on the map (Figure 6) the position of the fold is readily determined by an accurate detailed mapping of the surface formations.

Although there are possibly a few small structures especially between the Elstone structure and the Haass well and then in the area to the east, no other structures except the Devine and Yancey disturbances are known to be located in the southern half of Medina County.

Aside from the faulting and the folding in conjunction with the faulting in the northern part of the county, the four disturbances in Medina County of mappable size are the Culebra, Devine, Yancey, and Elstone structures. Of these four structures, the Elstone, the Devine and the Yancey folds have an economic significance.

Further detailed investigation for structures of economic value in connection with petroleum accumulation should be directed to the areas lying within the two lines of disturbance or folding described in connection with the Elstone, Devine and Yancey structures.

The Devine Structure

A fold, with its longer axis south of west and north of east, roughly parallel to the main folding and faulting in Medina County, is located some three miles northwest of Devine. On the surface of the structure, both the Seco and the Buttsgin formations of the Wilcox are exposed. The structure is known to be closed on the north, west and south. On the east, insufficient information has been obtained to determine if the fold is closed or if it continues to the eastward and is an extension of the Somerset field in the vicinity of Lytle. This structure is undoubtedly intimately connected with, and in origin related to, the Somerset structure. In all probability the same dynamic forces are responsible for the formation of both structures. The trend of the Somerset field if projected into Medina County will closely approximate the location of the Devine structure. From its eastern limit in Bexar County the Somerset field is very probably located on a series of folds lying along a folded zone which extends across Atascosa and into Medina County. How far into Medina County the disturbance along this line of weakness continues is not known, but it is quite possible that the disturbance dies out in the western part of Medina County as does the faulting along the southern side of the Balcones fault zone. This line of folding is comparable to the faulting along the south side of the Balcones fault zone since both disturbances are due to displacement chiefly along the main Balcones Fault. Since the southern faulting of the Balcones zone is closer to the main Balcones Fault the disturbance was in the nature of faulting, while along areas of the Somerset field and its extension into Medina County, the disturbance is marked by folding. This change in the type of structure from north to south in the county from faulting to folding is due to the less disturbed strata at an increased distance from the line of principal disturbance along the main Balcones Fault.

As the same formations are involved in the folded zone of the Somerset field, and since the disturbance probably occurred practically simultaneously over the whole disturbed area, conditions are undoubtedly very similar over the entire folded area. In Medina County, then, structural conditions on the Devine structure should be very similar to those found in Atascosa County. To the west, however, it is quite probable that the disturbance diminishes and dies out in the western part of Medina County.

The Yancey Structure

One mile northeast of Yancey, there is a small fold occupying the same geological position as the Devine structure. As no further disturbance could be determined to the west along this line, the Yancey structure is probably the western limit of the fold zone along which the Somerset field and its western extension, the Devine structure, are located.

The termination of the folding along this zone in the vicinity of Yancey practically coincides with the termination of the faulting along the southern side of the Balcones fault zone. There is practically no faulting along the southern side of the Balcones fault zone west of Hondo River, and the cessation of folding in the vicinity of Yancey, which is practically south of the termination of the faulting, indicates considerable relation between the two areas. In all probability they are due to the same disturbance and formed at the same time. The Yancey structure is apparently smaller than the Devine structure and under the conditions described this would be expected. It can also be stated in connection with the termination of faulting along the southern side of the Balcones fault zone, the termination of the fold zone at Yancey, and the absence of structure in the western part of the county similar to the Culebra structure of the eastern part, that the rapid decrease in the folding and faulting from east to west across the county south of the main Balcones Fault is quite evidently due to the smaller amount of displacement in the main Balcones Fault in the western part of Medina County. This decrease in the amount of displacement to the west in the main fault is clearly reflected in all structural conditions to the south which are dependent upon the main faulting.

ECONOMIC GEOLOGY

The mineral resources of Medina County include both the non-metallic and metallic groups. Only the non-metallic minerals are of commercial value. This group includes the water supply, clay, petroleum and natural gas, asphalt, brown coal, building and ornamental stone, gravel, cement and concrete metals, and road material. The metallics are confined to gold, silver, lead, and iron, none of which has been found in commercial quantities.

NON-METALLIC

Of the non-metallic minerals in Medina County four are of especial importance, namely, water, clay, petroleum and natural gas. These four minerals, if systematically exploited, should be of considerable economic value. The water and clay resources have received attention for some fifteen years. For a while their development was rapid, but the full extent of the resources is practically untouched. Much interest is now being shown in the prospecting for petroleum and natural gas. If this exploration is properly advised, petroleum and natural gas should be found in commercial quantities. However, the areas of possible production in Medina County are restricted and unless reliable geological information is obtained and the testing of these structures supervised by competent drillers, much time and money will be uselessly expended. The number of dry holes which are not on structurally favorable areas in comparison with the locations on structure, indicates the advisability of securing reliable geological information. The remaining non-metallic minerals have been utilized only to a small extent.

Water Supply

The water supply of Medina County may be classed under three heads; namely, surface waters, ground waters, and impounded waters. It is understood, of course, that each of the three classes is closely related to the other.

Surface Waters

The mean annual rainfall of Medina County is approximately 25 inches and the greater amount of this water comes in heavy rains for a short season in early spring and fall. Falling in this manner, at widely separated intervals, the water is of little value to flowing streams, except for a short period after the rainy season. As it falls quickly there is little opportunity for its absorption by the soil and consequently the larger part of the water passes directly over the surface of the ground, as run-off, into the drainage features. Thus for a short time after each rain the streams of Medina County are flowing, but throughout the greater part of the year, they are apparently dry. The Medina River, however, is an exception. It is a perennial stream and carries a considerable flowage of water all the year. Since the construction of the large irrigation dam on the Medina River in the northeastern part of the county, the stream flow is regulated and the amount of water it carries more uniform than formerly. At its source in Bandera County and throughout its entire course north of the area surficially covered by the Del Rio clay, the Medina River is fed by springs in the lower Comanchean limestones. The largest ones of these springs are of the fissure type.

The Hondo River and the Seco creeks likewise rise in Bandera County under conditions similar to those supplying the Medina River. Their supply of water, however, is more limited than the supply of the Medina River, and unlike the Medina River they are not visibly flowing streams throughout the year. After the rainy period the stream waters are visible, but in the dry season no surface waters can be found in their beds. However, they are known to flow throughout the most of the year, beneath the deep gravel deposits. This type of intermittent stream gives rise to water holes located in the larger depressions of the stream bed and fed by water flowing under the river gravel from springs and water holes farther up the stream. The remainder of the streams carry little water, practically throughout the year.

Thus the streams of the county are supplied during and immediately after rains by surface waters along their entire course, but for the greater part of the time are fed by springs in the limestones of the lower Comanchean.

Ground Waters

Ground waters, often referred to as sub-surface or underground waters, are of two types in Medina County; namely, flowing and non-flowing waters. Although there could be a further sub-division into springs and wells, this is unnecessary since it is quite evident that in a limestone country the source of wells and springs is the same. The wells merely tap the veins or channels in the limestone which carry water, while in springs the water follows the fissures to the surface.

Practically all of the ground water in Medina County is artesian; that is, it is under hydrostatic pressure. In the case of springs it is under flowing artesian conditions while in some wells there is insufficient pressure to produce a flow. In wells of this kind the water, though artesian and under sufficient head to rise a considerable height in the well, has not force enough to reach the surface and flow under its own head. The rate of flow of the flowing artesian wells and springs varies considerably. Both the physiographic and the geologic location of the wells and springs have much to do with the amount of water produced.

The chief water-bearing formations in Medina County are the Glenrose and Georgetown-Edwards limestones of the lower Comanchean. The majority of the wells in the central part of the county and all of those to the north and for some distance south of the main Balcones Fault, obtain their water from these formations. In the southern part of the county the Wilcox supplies considerable water; in some instances supporting flowing artesian wells such as the well on the Schmitt farm, two miles northeast of Yancey. The remaining Cretaceous and Eocene formations in Medina County carry little water.

Since the geological formations have a surface trend of outcrop south of west and north of east across the county, there are similar and characteristic water conditions intimately related to the geology of the county. Thus from north to south various water belts are encountered.

To the north of the main Balcones Fault there is much artesian water in the Glenrose limestone. The greater part of this artesian water is under sufficient hydrostatic pressure to flow. Throughout the Glenrose area there are numerous springs, some flowing as high as 500 gallons per second. Often these springs are located along faults which not only afford a vertical passage of the water to the surface along the fault plane, but through the faulting of impervious strata on the south against a water-bearing horizon on the north of the fault, furnish an impediment which causes the water to be retained under sufficient head to flow. In general, limestones are quite impervious throughout, and the water is generally carried along joint and bedding planes. This is very different from the conditions in sandstone where the water is carried more or less equally by all parts of the formation. The solvent action of the water along these joint and bedding planes has enlarged the cracks to fissures and channels, along which most of the water is carried. Thus in drilling for water it is necessary to tap one of these channels in order to obtain a satisfactory supply of water. The surface outlets of these channels form the fissure springs of the limestone region to the north of the main Balcones Fault.

On Cow Creek one mile from its junction with the middle Verde Creek, there is a small flowing artesian spring on the north side of a dike which has a northeast-southwest surface strike. This impervious igneous mass ascending along a fault plane has furnished an impediment to the water migrating southward along the dip of the Glenrose, and placed it under sufficient hydrostatic pressure to flow. The chief flowing springs not in the river bed or banks are Moccasin and Indian Springs, which are located at the main Balcones Fault. Indian Spring rises from the Glenrose limestone in the foot wall of the fault, while Moccasin Spring rises in the Edwards limestone immediately to the south of the fault. Practically all of the water in the central part of the county, between the Georgetown-Edwards area and the Wilcox area, is obtained by drilling through the overlying formations to the Glenrose or Georgetown-Edwards limestones. In the Wilcox area there are some flowing wells which obtain their supplies from the Wilcox sands themselves.

Since the Glenrose, Georgetown-Edwards, and Wilcox formations do not contain iron pyrites or sulphur to any great extent in Medina County, all of the water from these wells so far as known shows no traces of hydrogen sulphide. In the Austin formation the sulphur in the iron pyrite, which is a sulphide of iron, affords some sulphur water.

Impounded Waters

The available water supply for agricultural purposes is greatly increased in Medina County through the waters impounded by the irrigation dam of the Medina Irrigation Company. Two dams, the main dam, which impounds the water, and the diversion dam, which diverts the water supply from the river, are located on the Medina River 13 miles west of north from Castroville.

The main dam is 1580 feet long and 180 feet high. It is built in the north part of the area surficially covered by the Edwards limestone. In the river gorge, however, for a mile south of the main dam, the waters have cut through the Edwards limestone, exposing the Comanche Peak limestone, the Walnut clay and a small amount of the Glenrose limestone. The dams are on the first fault block approximately one-third of the distance from the main Balcones Fault on the north to the two parallel faults between the Georgetown-Edwards and the Austin, and the Austin and the Escondido on the south of the fault block. The main dam which impounds the water has a capacity of 254,000-acre feet. Above the dam the water spills into a deep canyon to the west of the dam and joins the original course of the river about a quarter of a mile south of the main dam. Along the wall of the spillway are numerous flowing springs. This water is supplied by the impounded water of the dam which escapes along joint and bedding planes.

Below the main dam is the diversion dam, the supply of which is regulated by the spill and gate supply from the main dam. The diversion dam diverts the water from the river channel into a canal, which, following along the sides of the hills, reaches the irrigated land. The diversion dam is 440 feet long and 50 feet high. It is an ordinary overflow type of dam. The irrigated lands lie west of Noonan and south of Lacoste, between the Southern Pacific and the International and Great Northern railroads.

Clays

Commercial deposits of clay so far as known in Medina County are confined to the Escondido formations of the

Upper Cretaceous and the Buttsgin formation of the Eocene-Wilcox. Though there are small clay deposits in the remaining Upper Cretaceous below the Escondido and in the Comanchean-Cretaceous, no deposits of workable size and quality are known. There are also deposits of clay in the Leona formation but these deposits as far as examined are too impure to be of value.

The most important clay horizon and the one from which the entire supply is now obtained, is the basal 200 feet of the Escondido formation. The clays are used entirely in the local manufacture of building brick and tile.

Building Brick

The clays used in the manufacture of building brick, in Medina County, are obtained from two pits in the vicinty of D'Hanis, in the western part of the county. Both of these pits are in practically the same horizon, which is 100 feet above the base of the Escondido. The plant of the D'Hanis Brick and Tile Company is located in the town of D'Hanis, while the pit is one mile north of west from the plant. The Clays are loaded into small cars and hauled by a locomotive over a narrow gauge road to the plant.

The clay pit is in the west bank of Seco Creek. In this area the creek has cut into its west bank leaving a vertical clay bluff of the Escondido which is about 60 feet high, with no recent deposits. The entrance to the pit is at the creek bank, from which a gentle incline extends the entire length of the present pit, which is approximately 800 feet. The incline of the floor of the pit from the entrance to the farthest working face affords excellent drainage so that little time is lost through delay from rains. From the entrance to the back of the pit the faces on either side of the pit are approximately 50 feet high and with less than four feet of Uvalde flint, caliche and soil as overburden. In most places the overburden is less than three feet. The deposit of clay is of such thickness and the relief of the country in the area of such nature that for the area of at least one square mile an average depth of 40 feet of clay can be obtained. This would allow the floor to be carried back with sufficient incline for drainage. Below this floor there is approximately 50 feet of material which is practically identical with that now being mined. Thus there is almost an unlimited amount of clay in this area, which can be mined in sufficient quantities and under advantageous conditions.

The clay is of a drab brown or drak brown color, on freshly exposed surfaces, but soon weathers to light brown or dark yellow. Throughout the entire pit the clay is remarkably uniform and with the exception of a thin limestone stratum, there is no waste. The total refuse is less than three-fourths of one per cent, and the normal run of the pit is used in making the brick. The clays are so much consolidated that blasting is necessary. Thus the working faces are practically vertical, the greater part of the time. The clay is remarkably uniform throughout, and there are three or four thin seams of deep red kaolinite about one inch in thickness. In these kaolinite bands there are numerous shiny, dark to slate gray sharks' teeth. At some localities the kaolinite bands are practically composed of the teeth. Occasionally throughout the pit, there is a *Pachydiscus*, which also aids in establishing the horizon of the Escondido as coming just above the *Exogyra ponderosa* horizon. There are also a few small oysters cf. *Ostrea cortex*, in the limestone ledge. In the clay are numerous veins and deposits of platy and fibrous selenite.

The clay when mined is loaded into small cars and hauled by a locomotive to the plant at D'Hanis, one mile distant. Eagle Pass coal is used in firing the locomotive.

At the plant the cars are run in at the top of a shed and unloaded. The clay is left in the mass in which it has been dumped for about a month. Different parts of the shed are emptied in succession in order that the clay may stand in piles and sweat. It has been found that the bricks are much more compact, have less cracks, hold a better edge, and are more durable, if the clay is allowed to stand about a month or more before being used. The moisture is also more evenly distributed through the mass and there is likewise less breakage in the bricks before as well as after burning.

The clay, after standing to sweat, is run through dryers which pulverize it, and then into the presses. From these it is carted to the kilns and stacked for drying and burning. The daily capacity of the D'Hanis Brick and Tile Company is 40,000 and the kiln capacity is 1,700,000. The bricks are dried for about a month under an even moderate heat and then are burned rapidly at a high heat for one week. The bricks burn to a light red and have an excellent finish, edging, and durability. Up-draft kilns are used, and Bastrop lignite is used both in the kilns and in firing the boilers for the engine. A 250-horsepower horizontal steam engine is used to furnish power. Mexican labor is used both in the pit and at the plant. The bricks are loaded by a revolving belt from the storage kilns into cars on a switch from the main line of the Southern Pacific Railway. At present the company is making only brick.

The plant of the Seco Pressed Brick Company is located one mile east of south from D'Hanis, at the north side of the Escondido escarpment. The pit is immediately adjacent on the south. A switch from the main line of the Southern Pacific Railway runs to the plant.

The pit, with a floor inclined toward the entrance, extends about 500 feet back into the escarpment. At this locality, the topography of the country is such that the floor of the pit is practically on a level with the plant, which is located on the plain at the foot of the escarpment. This affords about 75 feet of clay from the floor to the top of the escarpment. There is on an average two to three feet of Uvalde flint and caliche as overburden.

This pit, like the pit of the D'Hanis Brick and Tile Company, is in the basal Escondido, but approximately 50 feet higher in the section. The clays, as far as can be determined from a field examination, are identical with those in the pit of the D'Hanis Brick and Tile Company. On freshly exposed surfaces the clays are hard and generally a dark gray or dark brown. Upon exposure the clay weathers to a light brown or dark yellow. Considerable selenite was found. In the form of seams it is often platy, though sometimes fibrous. In small pockets it is generally fibrous. Very small seams of red kaolinite with sharks' teeth were found. In the limestone ledge, there are numerous small oysters resembling *Ostrea cortex*.

Throughout the entire 75 feet of the faces of the pit, there is only one thin ledge of limestone, which is less than one foot in thickness. It is estimated that the waste is much less than one-half of one per cent. The mining is chiefly done at the back wall of the pit, which is some 500 feet from the plant. When mined, the clay is loaded on small narrow gauge cars which run by gravity to the entrance of the pit. From this place they are pulled by cable with power supplied from the plant. To the east and south, especially to the southeast, there is practically an unlimited supply of clay which should be of as good quality as that being mined. There are at least two square miles which can easily be included in the area and the clay has an average thickness above the pit floor of 60 feet. Over the area there is also practically no overburden. It in all probability will not aggregate five feet. The overburden is composed chiefly of Uvalde flint and caliche.

The clays when dumped in the shed are allowed to stand for about a month, so that the moisture will be equally distributed through them. It is found that the sweating process greatly improves the material. Material fresh from the pit, if made directly into bricks, has a tendency to develop fine cracks, the edgings will not hold as well, and in general they are not as durable as bricks made from clay which is allowed to sweat.

The regular pit run of the clay is used and this produces an excellent quality of brick. The process of making and the length of time allowed for drying and burning is the same as that given for the D'Hanis Brick and Tile Company.

When burned the bricks are a bright red. They are then loaded on cars at the switch, which extends to the plant from the Southern Pacific Railway. In the company's engine, which hauls the cars to the main line, Eagle Pass coal is used. For the boilers, which furnish power for the plant, Bastrop lignite is used. The daily capacity of the company is 40,000 bricks and the kiln capacity is 2,000,000 bricks. All labor used in the plant is Mexican.

Petroleum and Natural Gas

Although petroleum has not yet been found in paying quantities[14] in Medina County, it is very probable that commercial production will be obtained when the proper structures are exploited.

Until relatively recent times, little attention has been given to the petroleum possibilities of the county, though practically every water well and test for petroleum south of the Southern Pacific Railroad has had showings of oil and gas.

Under geological conditions similar to those affording production in nothern Atascosa and Bexar counties, to the east, there should be commercial accumulations of petroleum in Medina County.

Of the various geological formations in the county which are within reach of the drill, the majority has not as yet afforded oil or gas in commercial quantities. There are, however, three formations which are known to carry petroleum in Medina County, and these formations under proper structural conditions should produce oil and gas in paying quantities.

It is not definitely known if the Carboniferous sediments underlie the Comanchean Cretaceous north of the main fault of the Balcones Fault zone. In Bexar County to the east, pre-Carboniferous schists underlie the Cretaceous to the north and for some distance to the south of the main Balcones Fault. It is possible, however, that the Carboniferous which is found underlying the Comanchean to the west may extend as far east as Medina County. At present no test in Medina County, north of the Balcones Fault, is deep enough to determine the nature of the sediments un-

[14]Since this report has gone to press, production has been obtained in the Medina Oil Development test on the Elstone structure.

derlying the Cretaceous. If the Carboniferous is present in the northern part of the county, it is possible that it may carry petroleum and production may be obtained by drilling through the Comanchean Cretaceous into the Carboniferous. It is very improbable that there are any Triassic or Jurassic sediments in Medina County between the Carboniferous and the Cretaceous deposits.

Though the Glenrose formation of the Comanchean Cretaceous frequently affords a showing of heavy asphaltic oil, no commercial production is obtained from it in any paying quantities. Thus if the Carboniferous is not present north of the Balcones Fault there is practically no chance of obtaining production in the northern parts of the county.

Likewise, in ascending order, the Walnut, Comanche Peak, Georgetown-Edwards, Del Rio, and Buda formations of the Comanchean Cretaceous can not be expected to afford oil. In none of the area adjacent to Medina County have these formations ever carried production and careful examination of their surface exposures in Medina County has revealed no trace of petroleum. Similarly, in subsurface explorations no showings of oil or gas have been found in these formations. The Eagleford shales are quite bituminous, but in adjoining areas under favorable structural conditions they have afforded no production.

It is quite possible that the oil in the Alta Vista and the Mission fields in Bexar County has migrated from the overlying Taylor formation into the upper part of the Austin chalk. The nature of the Austin formation, as well as the evidence that outside of the Alta Vista and Mission fields in Bexar County no oil has been obtained from it, practically precludes the Austin formation from the oil-bearing horizons.

Overlying the Austin chalk in Medina County is the highly petroliferous Anacacho limestone. At its surface outcrops it generally carries a considerable amount of asphalt. This undoubtedly is the dissipated product of the asphaltic oil which practically all tests that have penetrated this formation have obtained. This petroleum-bearing horizon correlates with the Taylor-Navarro horizon from which the production is obtained in the Somerset, South Medina, Alta Vista, Mission, and other fields in Bexar and Atascosa counties.

The Escondido has produced oil from various depths in the formation, notably in the vicinity of Haass in the eastern part of Medina County, and in the Medina Oil Development test on the Elstone structure. Eocene oil and gas are very probably present in commercial quantities in the Wilcox group. Northeast of Yancey in the Schmitt well gas and oil have been obtained from the Wilcox at 458 feet. The gas has sustained a flame two feet high from a two-inch pipe since the flow was struck in 1918. The presence of this oil and gas in a formation not universally carrying petroleum is of considerable significance.

The Carrizo formation does not carry oil or gas in Medina County. The Anacacho and the Escondido formations of the Upper Cretaceous and the Eocene-Wilcox carry petroleum in Medina County. Each of these formations at different places along the Balcones Fault zone has afforded petroleum in commercial quantities. Atascosa and Bexar counties adjoining Medina County on the east, very probably have production from each of these three formations.

Geological conditions influencing the concentration of petroleum in northwestern Atascosa and southwest Bexar counties should govern similar concentrations in southern Medina County. The least variation during the deposition of sediments over a limited area occurs parallel to the shore line. Similarly, at right angles to the shore line the greatest change in the nature of deposits is found. Thus in a north and south direction at right angles to the various Cretaceous and Eocene shore lines, in southwest Bexar, northwestern Atascosa, and southern Medina counties, there is considerable change in the deposits; while east and west, parallel to the shore lines, only small changes are found. It is therefore logical to anticipate production in structurally favorable areas in Medina County, which bear the same relations to the Cretaceous and Eocene shore lines that productive areas in Atascosa and Bexar counties bear to the same shore lines.

As the areas of greatest production in Atascosa and Bexar counties are the Somerset and South Medina fields, similar production can be expected in Medina County on structurally favorable areas, occupying a similar geologic position.

The surface outcrops in Medina County of the Anacacho formation, which horizon affords the greater part of the production in Bexar and Atascosa counties, is approximately east and west across the county two miles north of the Southern Pacific Railroad. This formation in general dips to the south from one to two degrees. Overlying the Anacacho are the Escondido and the Eocene formations outcropping successively toward the south and having a similar rate of dip to the south. In Bexar County, Gas Ridge, the Alta Vista, and the Mission fields obtain a smaller production than the South Medina and Somerset fields. Consequently, smaller production should be expected in Medina County north of the area occupying, with respect to the Cretaceous and Eocene shore lines, a position similar to that held by the Somerset and South Medina oil fields. In Medina County, as in Bexar County, the Anacacho and Escondido formations underlie the area to the north of the geologic position occupied by Somerset and South Medina oil fields. Under the existing structural conditions, there is a chance of such production as has been obtained in the Mission and Alta Vista oil fields.

In Medina County, then, practically the entire production may be expected from structurally favorable areas with a geologic location similar to the oil fields of Bexar and Atascosa counties.

Three structures have been located in Medina County, the stratigraphic and structural conditions of which, as well as the geologic location, indicate that conditions are favorable for a production similar to that of the fields of Bexar and Atascosa counties. As all the factors influencing production in the Bexar and Atascosa fields are present in these structures in Medina County, their production should be approximately the same in size as the fields of Bexar and Atascosa counties. There is some reason to anticipate a greater production from the Medina County structures than that which is obtained from the Bexar and Atascosa fields, since the fields of Bexar and Atascosa counties trend toward Medina County and in this direction the wells show a rapid increase in the amount of oil they produce.

Because of their proximity to the towns of Elstone, Devine, and Yancey, these structures will be referred to as the Elstone, Devine, and Yancey structures.

THE ELSTONE STRUCTURE

At Rock Crossing, on the Hondo River, about one mile south of the road leading due east from Elstone, the occurrence of large inlier of Escondido in the Eocene area indicates a very marked structure. To the north, approximately one and one-half miles above the Escondido inlier, there is an outlier of the Buttsgin formation of the Wilcox. The presence of the Wilcox, north of its respective area of exposure, and the occurrence of Escondido in the Eocene area, together with the dip of the Escondido, indicate a structure in this area approximately two miles long and one and one-fourth miles wide.

The Escondido inlier, which includes from the John Ward Survey at least the southeast third of the P. Tondre subdivision, all of the K. Crusturner subdivision east of the Hondo River, the F. Brucks, Weimer and J. Fusselmann (southeastern) subdivisions, the north central part of the Joseph Campbell survey and the western side of the Louis Graff and Jas. Boder surveys, indicates that the described area of approximately one by one and one-half miles is the highest part of the structure. This is evident since the Escondido projects through the Eocene formations, showing that considerable folding took place sometime after the deposition of the Wilcox. This folding was sufficient to elevate the Escondido so that when later erosion carried away the overlying Midway and Wilcox, the Escondido was exposed over an area of one and one-half miles and surrounded on all sides by the Wilcox. The amount of elevation must have approximated 200 feet, since some 20 feet of the Escondido, all the Midway, about 125 feet, and some 20 feet of the Wilcox have been eroded from the top of the structure. The structure at Elstone is a closed anticline or dome with the longer axis approximately east and west. From Rock Crossing or approximately from the boundary of the Weimer and J. Fusselman subdivision, east of the Hondo River, which is the top of the fold, there is a dip to the north and from the Buttsgin formation surrounding the Escondido inlier, toward the north, successively older formations are encountered till in the northern half of the Abraham Schmelzer survey, No. 19, the Escondido is again at the surface in its normal area of outcrop. At this locality also there is an outlier of the Wilcox, showing the area to be synclinal, with sufficient displacement to fold the Wilcox below its normal position, and protect it from erosion. It would seem, then, that the northern limit of the fold is about the middle part of the F. A. Brown subdivision of the Abraham Schmelzer survey, and that the area to the north is synclinal. How far to the east and west of the Cretaceous inlier the flexures of the fold extend, is not known, but they probably continue to the west as far as the western side of the John Ward Survey and to the east at least beyond the eastern edge of the J. Depres survey, and very probably much farther to the east.

As discussed previously under the Elstone structure, it is quite probable that a line of folding, or a line of weakness along which folding has occurred, lies between the Alta Vista and Mission fields in Bexar County, through the small structure on which the Haass well one mile northwest of Noonan is located, and to at least as far west as the Elstone structure. Thus the eastern extension of the Elstone structure evidently is considerably to the east of the Louis Graff Survey. It is quite possible that the area between the Elstone structure and Noonan is relatively a structurally high area and that smaller local structures will be found between these two localities.

Again in consideration of the relative size of the Elstone structure in proportion to the amount of displacement which has occurred, it is quite possible that the Elstone structure is of igneous origin. Molten magmas ascending along a fracture in the general area of weakness of the belt in which this structure occurs would produce a structure of this type. The igneous rock probably has ascended along a vertical passage for some distance, and in a laccolithic form. Since the structure apparently is nearly of equal axes, and since molten magma intruded into clay material has a tendency to penetrate equally in all directions, it would seem that the igneous rock has horizontally penetrated the Anacacho or basal Escondido formations.

Under such conditions the Elstone structure may possibly be comparable to the structure of the Thrall oil field. Since associated with the igneous intrusion on Cow Creek in the northern part of Medina County, there is a considerable thickness of dark green or chocolate-colored rock which is quite evidently a decomposed serpentine or chlorite analogous to the decomposed igneous horizon of greatest production of the Thrall field, there is reason to believe that a similarly metamorphosed rock may be found in the Elstone structure. Should such a metamorphosed rock be found in the Anacacho limestone or in the basal Escondido formation on the Elstone structure, there is reason to anticipate a production of oil similar to that of the Thrall field. However, the intrusion of an igneous mass into the petroleum-bearing Anacacho or Escondido formations, forming a dome like the Elstone structure, whether it has later been hydrated or not, should afford commercial production. By deductions from the conditions of occurrence of the Thrall oil, there is reason to expect greater initial production if the igneous rock which may be found on the Elstone structure be metamorphosed.

Although the Cretaceous exposure is longer north and south than east and west, it is quite evident that the longer axis is east and west. The alluvium and eroded Wilcox have so covered the area that it is impossible to determine if such is the case.

On the south the structure extends into and includes probably the greater part of the north half of the Joseph Campbell Survey No. 24. Since the long axis of the fold extends approximately due east and west, at Rock Crossing, and since in Bexar and Atascosa counties the south and southeast flanks of the structure are the most productive, it is very probable that the south flexure of the structure at Rock Crossing will afford larger production than the

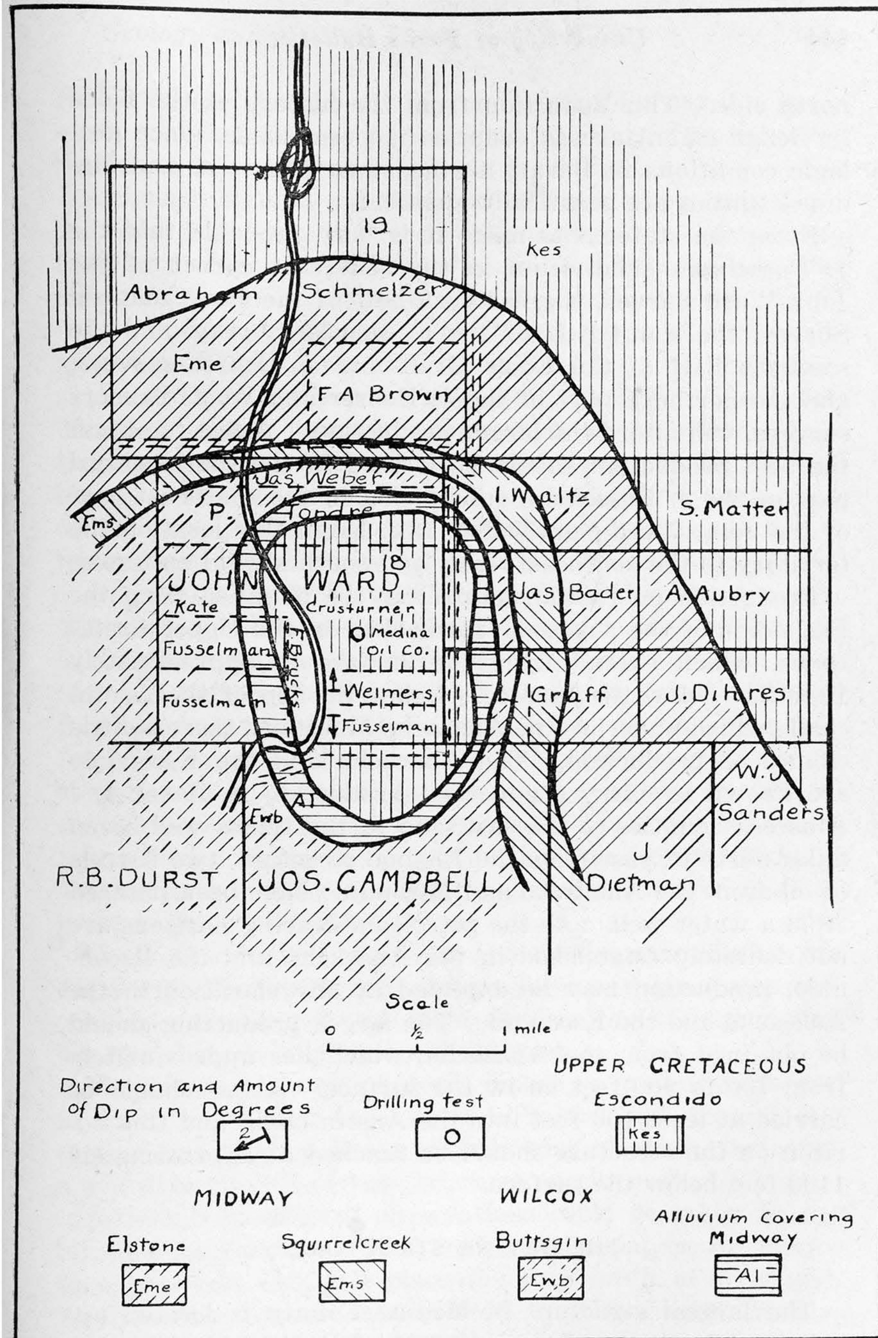

Figure 6
Geologic sketch of the Elstone structure

north side. This deduction from the history of the fields in Bexar and Atascosa counties is permissible, since geologic conditions in Bexar, northeastern Atascosa, and Medina counties are practically identical.

From the statements made it is very probable that the J. Fusselman subdivision in the southeast corner of the John Ward Survey, the northern half of the Jos. Campbell Survey, the south half of the F. Brucks Survey, and the southern half of the Louis Graff and J. Debres surveys, and the northern part of the J. Debres and W. J. Sanders surveys, will afford the larger production. A test to obtain the best production should be located in the south-central part of the J. Fusselman subdivision in the southeast part of the John Ward Survey No. 18. From this location the territory to the southeast, east, and south should be tested.

Production on this structure may be obtained from the Escondido or the Anacacho formations of the Upper Cretaceous, which extend from the surface to approximately 1000 feet below the surface. Below the top of the Austin chalk, which underlies the Anacacho limestone, there is little chance of production. The Anacacho and the Escondido are known to carry commercial production in Bexar and Atascosa counties to the east, and in the Haass well seven miles north of east from the Elstone structure, two barrels of oil from the Anacacho and Escondido have been pumped from a water well. As the petroleum-bearing horizons are not definitely established in the Anacacho and the Escondido, production may be expected at any elevation in the Anacacho and the Escondido. The larger production should be obtained from the Anacacho, which lies approximately from 700 to 900 feet below the surface. A test should be carried at least 100 feet into the Austin chalk and this horizon on the structure should be reached at approximately 1100 feet below the surface.

THE DEVINE STRUCTURE

The largest structure in Medina County is located approximately three miles northwest of Devine. It includes, as nearly as can be determined, the Caleb Kemp Survey

No. 7, the eastern half of the John George Survey, the area south of the surveys just referred to, and lying between the roads due north and due east from ZigZag.

Although detrital material has in most places concealed the Wilcox shales so that observations for structure can not be taken, sufficient information has been obtained to indicate a favorable structure within the limits defined.

In a borrow pit at the north side of the road, a quarter mile east of ZigZag, on the ZigZag-Devine road, the Wilcox shales dip two degrees slightly south of west. The exact direction of the maximum dip could not be observed as there was no exposure of the shales except in the side of the pit. The observed dip, even though only a component of the true dip, indicates considerable disturbance, since the regional dip of the Wilcox is south to southeast.

Approximately one mile north of ZigZag the dip is south of west. A half mile west of this locality a dip two degrees to the southeast was observed. Thus the northwestern edge of the structure would seem to lie between these localities. One-half mile east of Black Creek, two miles east of north from ZigZag, a dip three degrees to the northeast was found at the north of the road. One mile west of this locality at the bridge over Francisco Creek, the Wilcox shales are again found to dip to the northeast at the rate of two degrees. To the north of this area the regional dip is about two degrees to the southwest.

One-half mile west of Devine the dip was found to be two degrees to the southwest. At a road cut in a hill one and one-half miles northwest from Devine, the Wilcox shales dip five degrees slightly south of west.

Though no observation could be taken immediately east of Francisco Creek because of alluvium, the general dip east of this locality, being slightly east of south, indicates a probable closure of the structure on the east.

Although insufficient observations could be taken to determine the exact axis and the highest point on the structure, the data obtained place the axis south of west and north of east through the middle of the Caleb Kemp Survey No. 7, and the highest area of the structure along the northern side of the MacMillan property, a quarter mile west of Francisco Creek, and a quarter mile north of the road crossing the southern part of the Caleb Kemp Survey.

From the direction of dip records in the map it would be possible to conclude that the axis of the Devine structure trends north of west. However, it is not known if the dips are maximum of component dips so their direction does not exactly indicate the location of the axis. There are dips of the amount recorded in the direction shown, but it is possible that the true dips may be even greater and those on the north side of the axis dip more nearly north and those on the south side, south or southeast. However, a closure of the structure on the east, or various possible modifications of a plunging anticline or inclined terrace, could easily give the recorded dips.

From the direction of the fault strikes, folds, and the outcrops of the formations in Medina County, as well as the course of similar structural features in Bexar and Atascosa counties to the east, all of which to a greater or less extent have determined the axis of the Devine structure, it is very probable that as stated the axis of the Devine structure has a bearing of slightly south of west.

From the production obtained in the Somerset, South Medina and in fact all the fields of Bexar and Atascosa counties, it is quite evident that the greatest concentration of petroleum is on the southeast limb of the structure. This would normally be expected since the southeast flexure of the structure is more gently inclined and the regional dip is to the southeast, thus affording drainage from a larger area. On the northwest the limb is relatively short, with little drainage area.

The most valuable part of the Devine structure then is the area lying southeast of a line drawn slightly south of west approximately through the center of the Caleb Kemp Survey No. 7. Again, since the dip rapidly increases from west to east across the structure, the most favorable area is the southeastern quarter of the Caleb Kemp Structure No. 7, and the land immediately adjacent. A test to ascertain the value of the structure should be located south of the axis, preferable a quarter of a mile west of Francisco

Creek, and a quarter mile north of the road crossing the southern part of Survey No. 7.

There are three possible horizons of production in the Devine structure. The first may be obtained from lenses in the Wilcox shales. These shales should extend from the surface to about 700 feet. Gas and oil have been obtained in small quantities in the Schmitt well two miles northeast of Yancey from various depths in the lower middle and base of the Wilcox shales. The lowest showing in the Schmitt well may possibly be from the Midway. Not enough drilling has been done to determine if there are any definite oil-bearing horizons in the Wilcox in Medina County. It is possible that the petroleum will be obtained in the Wilcox entirely from lenses at various depths and that there will be no uniformity or regularity of the horizon.

In the upper and middle parts of the Escondido formation, oil and gas have been obtained from the Haass well, four and one-half miles southwest of Dunlay, and from the Medina Oil Development Company test at Elstone.

Both of the horizons mentioned, though not yet having produced oil in paying quantities,[15] carry petroleum and are possible commercial horizons.

The Anacacho limestone, correlating with the Taylor-Navarro horizon of the Somerset and South Medina fields of Bexar and Atascosa counties, is the principal horizon from which production can be expected. The physical properties of this formation enable it to contain oil and in this area the structural conditions are favorable for the concentration of petroleum. The extension of the Somerset field with increased production to the southwest in Atascosa County, almost to the Medina County line in the vicinity of Lytle, and the general petroliferous nature of the Anacacho formation over Bexar and Atascosa counties, and Medina County as shown from the various tests which have penetrated it, indicate that it may reasonably be expected to carry production in the Devine structure.

In the Haass well, which is located as far west in Medina

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[15]The Medina Oil Development Company has encountered production in the Escondido since this report went to press.

County as the Devine structure, and much farther from the Alta Vista and Mission oil fields than the Devine structure is from the Somerset field, there is production in the Anacacho limestone equal to that of the Alta Vista and Mission fields. Since, to the north, the Anacacho limestone horizon uniformly carries oil at least as far west into Medina County as the Devine structure, it is reasonable to expect production from the Devine structure similar to that of the Sòmerset field, since the same horizon furnishes the oil in all of these localities.

The Anacacho horizon should be reached at a slightly

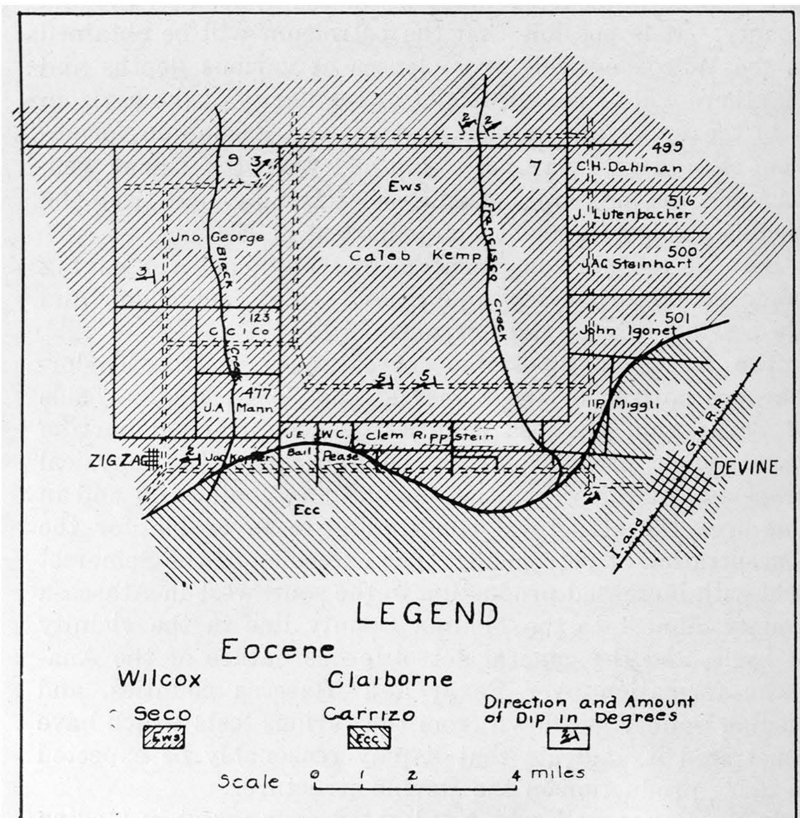

Figure 7

Geologic sketch of the Devine structure

greater depth in Medina than in Atascosa county, because of the plunge of the formations to the southwest. In Atascosa County the depth required to reach the Anacacho horizon is somewhat greater than that required in Bexar County. A test 1800 to 2000 feet will probably be required to reach this horizon; and to thoroughly test it, a hole should be carried 2500 feet or deeper, if necessary, to reach the Austin chalk. When the upper 100 feet of the chalk are penetrated there is little use in carrying the hole to a greater depth.

THE YANCEY STRUCTURE

A second structure from which oil and gas in paying quantities can reasonably be expected, is located approximately one and one-half miles northeast of Yancey. In this region also detrital material has to a great extent concealed the Wilcox, which is the surficial formation. In a few places as noted on the accompanying maps, observations of dip were possible and these indicate a favorable structure for the accumulation of oil and gas. The nature of the disturbance in this region can not be determined accurately because of the absence of adequate exposures, but it is very probably a structure similar to the one described as the Devine structure, though perhaps smaller in extent. There are included in this structure Surveys 807, 808, 809, 540, 524, 525, 118, 520, 523, and the northern half of Surveys 806 and 810. Possibly more territory could be included in the structure if more exposures were present to afford information.

From the available data it seems quite evident that the well on the L. H. Schmitt farm, in the southwest corner of Survey 526, is near the top of the structure but on the north side of the axis. If this is the case, it would be advisable to drill on the south side of the axis, in the central or south-central part of Survey 807 or Survey 808, as explained in the discussion of the Devine structure. Although production might be obtained on the north side of the structure, the development of similar structures in Bexar and Atascosa counties to the east has shown that the southern flexure of the structure is much more productive. In this structure the same formations described as possible productive horizons in the Devine structure may be expected. It is quite probable also that they will be found at approximately the same depth as the same formations in the Devine structure, or slightly deeper. Although the Yancey structure is farther to the west it is not known that the plunge of the structures continues to the southwest, and the Yancey structure occupies about the same geological position in respect to the Wilcox outcrop.

Oil and gas are known to be present in the lower part

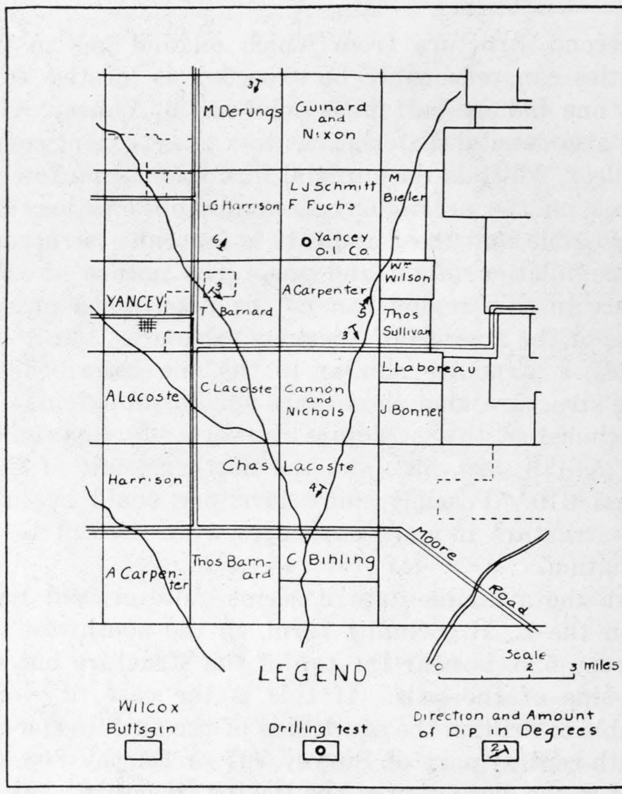

Figure 8

Geologic sketch of the Yancey structure.

of the Wilcox shales in this area. The L. J. Schmitt well passed through shows of oil and gas from 450 to 475 feet and has been flowing sufficient gas from a two-inch pipe for two years to sustain a flame over one foot long. It is reported that considerable oil sufficient for a five-barrel well was encountered at 458 feet.

Since the Wilcox, which is not universally an oil-bearing horizon, carries petroleum at this locality, it is reasonable to expect production from a horizon which carries commercial quantities of petroleum under similar conditions in the adjacent county.

ASPHALT

Surface deposits of asphalt are known at two localities in Medina County. Both of these asphalt seeps are in the Anacacho limestone.

In the bed of San Geronimo Creek one-half mile southeast of Rio Medina, the Anacacho limestone contains considerable asphalt. From the size of the seep and the amount of asphalt it is doubtful if the mineral is present in commercial quantities. On Seco Creek two miles north of D'Hanis there is an asphalt seep of considerable size. On the south the seep is bounded by a fault, to the north of which the asphalt has ascended along the inclined strata and encountered the less pervious clays of the Escondido, which at this locality are downthrown against the Anacacho. Only some 12 feet of the Anacacho directly underlying the Escondido are exposed on the north side of the fault. The seep is approximately 100 feet long. A measurement of its depth could not be obtained as there are no water wells or other subsurface explorations in the immediate vicinity. There are at least 12 feet of thickness in the seep in the local area of the creek bed.

To the west of the creek there are about 20 or 30 feet of Escondido clay as cover, while to the east of the seep there are from 10 to 15 feet of Recent alluvium. It is possible that if examined carefully the seep would be found to be of commercial value. For such an examination it would be necessary to make a number of tests with a diamond drill to ascertain the thickness of the seep. The Anacacho limestone, which at this locality contains the asphalt, is estimated to hold about 10 per cent of asphalt. The locality is two miles from D'Hanis on the Southern Pacific Railroad, and the intervening wagon road affords easy transportation.

BROWN COAL

In the vicinity of Lytle in the southeastern part of Medina County, workable deposits of brown coal have been found in the Wilcox shales. These coal deposits occupy lens shaped areas and apparently were deposited in shallow basins, probably small shore swamps or marshes. Until recently the mines have been open and some work has been done for many years. Because of the geology and topography of the country, the mines were located on a plain and were either open pits or mines reached by vertical shafts. Since mining has begun on the lower levels, there was always much water trouble. Being thus located on a plain, and being an open pit or mine reached by a vertical shaft, there was no natural drainage. Consequently in order to drain the mines, it would have been necessary to install pumps to lift the water to the surface. The nature of the deposits of coal, however, did not seem to warrant this expenditure and recently the mines have been abandoned and filled in with the refuse from workings.

BUILDING AND ORNAMENTAL STONE

Stone suitable for building and for ornamental purposes is abundant in Medina County. The principal formations which furnish building stone are the Glenrose, Edwards, and Georgetown of the Comanchean, and the Escondido of the Upper Cretaceous; while ornamental stone is confined to the Edwards and the Georgetown formations. Throughout the Eocene there are no suitable building stones. These formations consist for the most part of soft, impure, argillaceous and glauconitic limestone, clays, arenaceous shales carrying sandstone, and limestone lenses, which are not suitable for structural purposes.

Although there are harder and more calcareous strata in the Glenrose which are suitable for building purposes, the amount of waste in the form of interbedded marls makes it unprofitable to quarry from this formation except for local consumption.

The Georgetown and Edwards formations are the chief horizons both for building and ornamental stones. The limestone is remarkably uniform and free from waste and its physical characters are adequate to enable it to resist erosion to a great extent. In color it is light gray to almost white with little iron, which in weathering would cause black and brown stains. Frequently the limestone is full of the calcitized remains of various fossils. When the stone is polished these fossils are clearly outlined in the limestone by the calcite replacements and make a beautiful stone for decorative purposes.

The Del Rio, Buda and Eagleford formations afford practically no suitable building stones. Though they have been used locally, the stones from these formations are of no commercial value. The few limestone ledges of the Del Rio and Eagleford have a good uniformity of thickness, but the amount is insufficient to be of any economic value. The Buda is generally too nodular to be of any importance. Local areas which are not nodular could be utilized, however.

The stones of the Austin chalk and the Anacacho limestone are too soft and porous to be of value for building purposes. Though there are a few sufficiently indurated ledges at the base of the Austin chalk and in the Anacacho limestone in the western part of the county, the amount is not sufficient to be of economic importance.

GUANO

Commercial deposits of guano are found in the bat caves two miles southwest of the King ranch-house in the northern part of the county. These caves are in the Glenrose limestone and are of considerable size. The caves are cleaned every six months or once a year, depending on the rate of accumulation of the guano. The mineral is hauled to Hondo by mule team, where it is loaded on cars. The principal expense connected with the industry is the expense of hauling over the rough road from the caves to Hondo. The distance is approximately twenty miles.

CEMENT AND CONCRETE METALS

Materials for the use in concrete are practically unlimited in Medina County. The limestones of the Glenrose, Edwards, Georgetown, Buda, basal Austin, Anacacho, and Escondido, furnish an unlimited supply while the deposits of gravel in the river and stream beds can hardly be exhausted. Along the Hondo and Medina rivers the Seco and Verde creeks, deposits of limestone and flint gravels mixed with a small amount of igneous material continue with a depth of 30 to 40 feet practically along the entire stream courses. All of these deposits of gravel are within hauling distance of the Southern Pacific Railroad.

In connection with the sources of the concrete metals in the county there is associated the possible economic importance of the undeveloped Portland cement resources in the county. Though there are no cement plants in the county, favorable localities for the construction of such plants are present.

Since in the manufacture of Portland cement both limestone and clay are used in their respective proportions of about three to one, a plant must have easy access to both materials. In the area across the county surficially occupied by the upper Georgetown-Edwards formation, the Del Rio, Buda and Eagleford, there are possible locations of cement plants within a distance of from eight to ten miles of the Southern Pacific Railroad. The Georgetown limestone is practically free from flint and has a uniform high percentage of calcium carbonate. The supply of limestone of adequate qualities is practically unlimited. Overlying the Georgetown limestone is some 60 to 70 feet of Del Rio clay which is apparently suitable to furnish the required kaolin. Then overlying the Del Rio clay is the Buda limestone, some 60 feet thick, which is also adequate to furnish the required lime. Above the Buda limestone are the Eagleford clay-shales, which have a sufficient kaolin content. The geological conditions in the belt of country including the Georgetown, Del Rio, Buda and Eagleford formations are favorable for the location of cement plants. The cost of transportation to a railroad, however, must be considered in the contemplation of the establishment of cement plants in this county.

ROAD MATERIALS

There is an almost unlimited amount of material for use in the construction of roads or for ballast in railroad work. Practically all of the Comanchean-Cretaceous formations have limestone of sufficient strength to be entirely adequate for crushing and use in waterbound macadam and other types of roads which demand crushed rock. In addition, throughout practically the entire length of the majority of the streams of the county, there are large deposits of limestone gravel, with which is mixed some flint and a few igneous pebbles. The greater part of this material is of suitable size for road use. Different parts of the various deposits vary in size so that graduated material from a coarse subbase to a fine crown material may be obtained. Since the greater part of the roads in Medina County, with the exception of the northern and southern ends of the county, is built over heavy black clay loam, practically all that is necessary for a durable road is proper ditching and the placing of from six to eight inches of gravel in the road bed. In places where the roads cross a relatively low area, a sub-base of coarser material will be necessary. The clay is sufficient to hold the gravel in place, and gravel roads of good quality and durability can be constructed at a minimum cost. With such a road base and the nature and amount of the gravel procurable, it is unnecessary to construct macadam roads which require crushed rock. The Uvalde formation also contains a great amount of flint boulders from one to four inches in diameter. This material, generally present on the upland, could be used in the areas farthest away from the stream deposits of gravel, or the older terrace gravels.

By utilizing both the limestone gravel of the stream valleys and the Uvalde flint in areas removed from the streams, there are few places in the county where the hauling should be over five miles. On the main roads the greater amount of the hauling will be under three miles.

METALLICS

The metallic minerals, though not of commercial value in Medina County, include gold, silver, lead and iron.

Gold

Small quantities of gold have been found in the basal Carrizo outlier one mile northeast of Bailey Lake, three miles southeast of Yancey. The gold is here found associated with the coarse, red ferruginous sandstone of the basal Carrizo. A shaft 90 feet deep has been sunk at this locality. The uppermost nine feet of the material penetrated in the shaft are Carrizo and the remaining 81 feet to the bottom of the test are in the Seco shales of the Wilcox. The assay of gold per ton of material was very low, as there is a very small thickness and distribution of the Carrizo at this locality, the deposit is of no commercial value. Gold in practically negligible quantities has been found associated with the igneous intrusion in the northern part of the county.

Silver, Lead and Iron

In association with the igneous intrusions in the northern part of the county, some prospecting has been done and these prospects have shown deposits of silver, lead and iron, none of which is of commercial value. These minerals are found as an enrichment in the amygdaloidal basalt and the Glenrose and Edwards limestone at its contact with the igneous intrusions. Iron in the form of limonite and hematite, probably weathered to that form from siderite, is present in much greater quantity than either silver or lead, but not in sufficient quantities to be of economic value. A shaft

70 feet deep has been sunk at the south side of the dike on Cow Creek. The location is in the metamorphosed Glenrose limestone at its contact with the basalt. This test being so located should show any mineral deposits if present, as the shaft is within the zone in which enrichment should have taken place. At the igneous neck half a mile south of the Mumme Ranch, a pit some eight feet deep has been dug but no commercial deposits of minerals have been found.

A specimen of marcasite was identified but the only information of its locality was that it was from the northern part of Medina County. No other specimens of this iron ore were found.

SUBSURFACE DATA

The information included under subsurface data is derived chiefly from logs of water wells and tests for petroleum which have been drilled in Medina County. Relatively few wells and tests have been drilled in this county in comparison with the number in adjoining counties. Of the number completed in Medina County, only a small percentage has any record whatever of the strata penetrated.

In the northern part of Medina County there are at present no tests for petroleum and with the exception of the diamond drill core herein included, there are no records of the strata penetrated in subsurface explorations in the northern part of the county. However, since water wells in northern Medina County are only carried into the Edwards or Glenrose formations of the Comanchean-Cretaceous, no information can be expected from these wells regarding the nature of the pre-Cretaceous material underlying this area. Though the diamond drill record of an exploration at the main irrigation dam site affords a detailed record of probably the entire thickness of the Glenrose limestone, it is quite evident from an examination of this record that when abandoned, the test was still in the Glenrose formation.

Record of diamond drill hole No. 4 at dam site of main (upper) dam of the Medina Valley Irrigation Company, on the Medina River, about 18 miles north of Castroville. By Alexander Deussen.

Elevation of ground at well, 930.41 feet

Medina Dam Site Boring

No. of sample		Depth feet below surface
112.	a. 18″ blue compact shale	
	b. 5″ friable blue argillaceous sand	
	c. 3′ blue compact shale at bottom of hole, at 62.25....	67.33
111.	a. 2′ blue compact shale	
	b. 1′ fossiliferous shale..........	72.50
110.	a. Green, calcareous, apparently glauconitic sandstone	
	b. 1′± hard blue porous sandstone, only slightly calcareous	
	c. Green glauconitic hard calcareous limestone	
	d. 18″± calcareous	
	e. 6″ fossiliferous blue limestone	
	f. 3′ blue compact very slightly calcareous shale......	82.44
109.	a. Blue, hard, porous sandstone, only slightly calcareous	
	b. At base, 2″ of blue argillaceous sand..........	92.33
108.	a. Blue porous limestone, upper 4″	
	b. Blue fossiliferous limestone, 1′±..........	102.34
107.	a. Upper 2′ porous gray limestone	
	b. 2′ fossiliferous limestone, fossils calcitized	
	c. 3′ blue argillaceous fossiliferous limestone	
	d. At base, 2″ of blue argillaceous sand..........	112.31
106.	a. Porous gray limestone	
	b. At base, about 4″ of blue argillaceous sand........	122.66
105.	a. Porous gray limestone	
	b. At base about 3″ of blue argillaceous sand........	132.51
104.	a. Upper 2′ porous gray limestone	
	b. 1′ compact gray limestone	
	c. 1′ blue calcareous argillaceous sand	
	d. At base, about 6″ of porous gray limestone........	142.75
103.	a. 7′ porous light gray limestone	
	b. 8″ blue argillaceous calcareous sand	
	c. 1′ gray limestone with streaks of shale..........	152.48
102.	a. Upper 4′ porous gray limestone	
	b. 2′ compact gray argillaceous limestone	
	c. 2′ porous gray limestone	
	d. 6″ blue argillaceous sand..........	162.54
101.	a. Gray fossiliferous limestone	
	b. Near base, about 4″ of blue argillaceous sand	
	c. Lower 2′ porous limestone..........	172.58
100.	a. Gray limestone with planes of calcite crystals	
	b. At base, about 4″ of blue argillaceous sand......	182.48
99.	a. Gray limestone, apparently fossiliferous, geodes	
	b. About 2″ of blue argillaceous sand at base........	192.37

98.	a. Gray limestone, with small geodes containing calcite crystals, geodes about ½″ in diameter b. About 5″ of blue argillaceous sand at base	202.50
97.	a. Gray limestone b. A layer of blue shale, about 6″ thick, near middle c. At base, about 4″ of blue argillaceous sand	213.04
96.	a. Upper 5′ gray limestone b. Lower 2′ blue fossiliferous limestone c. At base, 2″ of blue argillaceous calcareous sand	222.71
95.	a. Gray limestone with some wavy laminae of shale in places b. 2″ of blue argillaceous calcareous sand at base	232.54
94.	a. Gray limestone with wavy laminae of shale b. Parting layer at base of 2″ of blue argillaceous sand	242.83
93.	a. Gray limestone b. 3″ of blue argillaceous sand	252.56
92.	a. Gray limestone b. Near base, about 2″ of blue argillaceous sand	262.62
91.	a. Gray limestone b. Near base, about 2″ of blue argillaceous sand	272.75
90.	a. Blue argillaceous fossiliferous limestone b. Lower 3′ not so argillaceous c. At base, about 1″ of blue argillaceous sand	282.58
89.	a. Gray limestone, apparently fossiliferous followed by about 2″ of blue argillaceous sand b. At base, about 2″ of blue argillaceous limestone	292.70
88.	a. Upper 18″ blue calcareous shale b. Lower 4′ gray limestone c. At bottom, about 1″ of blue argillaceous sand	302.58
87.	a. Gray limestone b. Lower 3′ bluish-gray calcareous shale c. Near bottom, about 2″ of blue argillaceous sand	312.79
86.		
85.	a. Soft fairly coarse-grained gray limestone b. Near base, about 2″ of blue argillaceous sand	321.66
84.	a. Blue argillaceous limestone b. Lower 2′ more marly	332.65
83.	a. Gray compact limestone b. Near base, about 2″ of blue argillaceous sand	342.50
82.	Blue calcareous shale	346.45
81.	Blue hard compact calcareous shale	352.57
80.	a. Greenish-gray argillaceous limestone b. Lower 1′ calcareous shale	362.66
79.	Blue argillaceous limestone	372.35
78.	Blue hard calcareous shale	382.32
77.	Porous white limestone	392.50

76.	a. Coarsely porous fossiliferous limestone	
	b. 3″ blue argillaceous sand	402.50
75.	a. Fossiliferous gray porous limestone	
	b. 3″ blue argillaceous sand	412.48
74.	a. ½′ coarsely porous limestone	
	b. 5″ blue argillaceous sand	422.60
73.	a. 1′ gray fossiliferous limestone	
	b. 2′ greenish-gray, porous, slightly calcareous sandstone	
	c. 18″± fossiliferous gray limestone	
	d. 2″ blue argillaceous sand	432.46
72.	a. 3′ porous fossiliferous limestone	
	b. 3″ blue argillaceous sand	
	c. 2-¾′ porous fossiliferous limestone	
	d. 3″ black shale	442.61
71.	a. 18″ blue friable calcareous shale	
	b. 18″ blue compact granular calcareous shale	
	c. 1′ blue compact shale	
	d. 3′ porous gray fossiliferous limestone	
	e. 4″ blue argillaceous friable sand	452.63
70.	Blue calcareous shale, lower 3′ not so compact	462.48
69.	Blue calcareous shale	472.20
68.	a. Gypsum or anhydrite	
	b. Near base, 2″ of blue argillaceous sand	482.31
67.	a. Upper part blue shale	
	b. Middle part gypsum	
	c. Lower 3′ blue argillaceous limestone	492.62
66.	Blue compact argillaceous limestone	494.58
65.	Blue argillaceous limestone	501.89
64.	a. Blue shale	
	b. Near base, 2″ of blue argillaceous sand	507.00
63.	Blue calcareous shale	512.84
62.	Blue calcareous shale	522.20
61.	Blue calcareous shale	526.58
60.	a. Gray limestone	
	b. Near base, 2″ of argillaceous blue sand	532.52
59.	a. Gray limestone	
	b. Near base, 2″ of argillaceous sand	?548.57
	b. Near base, blue argillaceous sand	552.62
58.	a. Blue compact shale	
57.	Blue calcareous shale	556.55
56.	Blue calcareous shale	557.83
55.	Friable blue marl	562.58
54.	a. Coarse gray limestone	
	b. Near base, 6″ or argillaceous blue sand	572.78
53.	Gray limestone	582.60

52.	Gray limestone	592.45
51.	Light gray limestone	602.58
50.	White limestone	612.10
49.	a. Greenish-gray calcareous shale for upper 6″ b. Lower 14″ white limestone	614.31
48.	a. Bluish-gray hard calcareous shale b. Some 18″ of grayish-white limestone	622.20
47.	a. Gray limestone b. Near base, some blue argillaceous sand	628.67
46.	Limestone with specks of shale	631.62
45.	a. Gray limestone, just above bottom, streaks of shale b. Lower 6″ blue argillaceous sand	636.41
44.	Gray limestone	637.41
43.	a. Fairly porous gray limestone b. Lower 6″ gray argillaceous sand	642.53
42.	a. Upper 2′ compact gray limestone b. Lower 1′ porous limestone with black specks	652.50
41.	Light gray limestone	662.83
40.	Compact gray limestone	672.54
39.	a. Upper 1-½′ mostly gypsum b. Lower 5′ compact sandy bluish-gray limestone	682.83
38.	a. Upper 2′ bluish-gray calcareous shale b. Lower 3′ gypsum	692.59
37.	Hard bluish-gray calcareous shale	702.33
36.	Gypsum(?)	702.75
35.	a. Upper 2′ is hard gray limestone, with black specks b. Lower 2′ gypsum, possibly anhydrite	712.46
34.	a. Upper 3′ gray hard compact limestone b. Lower 15″ more argillaceous	722.49
33.	a. Bluish-gray limestone b. Near base, about 4″ of bluish-gray argillaceous sand	732.59
32.	a. Bluish gray marl b. Near base, about 4″ of bluish-gray argillaceous sand	742.50
31.	Porous, apparently sandy limestone, with some clay in places (in streaks)	752.79
30.	a. Bluish-gray marly limestone b. Near base, some plastic bluish-gray marly sand	762.50
29.	a. Upper 2′ blue calcareous shale b. Lower 2′ slightly harder, less argillaceous limestone	772.18
28.	a. Compact bluish-gray limestone b. 10″ above base about 3″ of bluish-gray calcareous shale	782.10
27.	a. Upper 18″ is gray argillaceous limestone b. Lower part bluish-gray marl	791.93
26.	Blue argillaceous limestone (bore reduced, 2″ to 1″)	800.99

25.	Blue, soft, marly limestone with some streaks of shale	811.39
24.	Gray, coarse-grained limestone	821.05
23.	Gray limestone with some streaks of shale	827.01
22.	Coarse-grained gray limestone	831.01
21.	Blue limestone, porous in places	840.81
20.	Blue argillaceous limestone, fairly soft	847.06
19.	Blue compact limestone	851.72
18.	a. Near top about 1′ of porous, blue, slightly calcareous sandstone	
	b. Remainder of core blue compact limestone	861.39
17.	Blue limestone, slightly porous near center	871.63
16.	a. Blue marly limestone; lower 2′ fairly porous in places	
	b. At very base about 2′ of plastic blue marl	880.95
15.	Soft marly limestone	884.43
14.	a. Fairly hard, gray calcareous shale	
	b. At bottom about 2′ of gray limestone	890.44
13.	a. Porous, light gray calcareous sandstone	
	b. Near base, about 3″ of blue semi-plastic marl	896 34
12.	Compact soft marly limestone	897.31
11.	a. Near top about 5″ of porous calcareous bluish-gray sandstone	
	b. Below about 12″ of compact gray limestone	899.50
	Bottom of Core No. 10	899.50
10.	Compact bluish-gray limestone, near top of this some soft marl penetrated, possibly as much as 4″; near bottom some soft blue marl, possibly 2″	901.73
9.	Medium-soft argillaceous limestone in places porous	911.66
8.	Blue-gray compact limestone	914.83
7.	Porous blue calcareous sandstone	917.93
6.	Blue argillaceous soft limestone	921.83
5.	Bluish-gray compact limestone	824.28
4.	Bluish-gray compact limestone	925.63
3.	Compact, hard, gray limestone, apparently contains some sand	927.83
2.	Missing	
1.	Coarsely porous, white, soft limestone, slightly argillaceous	930.41
	Total thickness of strata examined	868.16

Samples of all fossiliferous rocks were sent to the U. S. Geological Survey in Washington, and duplicate samples of fossils are in the possession of Alexander Deussen, Houston, Texas.

Since the exact location of this test is not known it is impossible to state definitely if the test begins in the top of the Glenrose or the basal Edwards. An examination of the data has shown that if the drill hole was begun in the Medina River channel, the surface formation is the Glenrose. However, if the location is at the top of the canyon on either side of the river at this locality, the surface formation is the basal Edwards. Since the Walnut and Comanche Peak formations in this region are found only in the canyon walls which are practically vertical, they are eliminated from possibility of being surface formations. From the descriptions of the first samples of the core, it is evident that at 67.33 feet the formation is Glenrose. It is possible, however, that the Edwards formation occupies the position between the surface and 67.33 feet. Of this part of the test there is no record.

Haass Ranch Well

Log of George Haass Ranch well, four and one-half miles southwest of Dunlay, Medina County. Completed January 3, 1902. Authority, M. M. Gervin, driller. The 10″ drive pipe was left in the well and the sandstone at 227-228 feet furnishes about two and one-half gallons of soft water per minute by pumping. Well mouth is about 1000 feet above sea level.

	Depth in feet below surface	
Soft white limestone	0	15
Soft yellow clay	15	57
Close blue clay; landed 10″ drive pipe at 211′	57	216
Hard gray sandstone	216	220
Soft blue clay	220	227
Soft white sandstone; water-bearing	227	238
Soft blue clay	238	259
Hard gray sandstone	259	265
Soft blue clay	265	350
Soft gray sandstone	350	356
Soft blue clay	356	366
Soft gray sandstone	366	371
Soft blue clay	371	494
Soft brown sandstone; small show of oil and gas; landed 8″ drive pipe at 507 feet	494	529
Soft blue clay	529	584
Hard gray sandstone	584	592
Hard blue clay	592	602
Hard blue sandstone	602	639
Very fine and hard gray sandstone	639	659
Hard dark shelly sandstone	659	674
Hard blue sandy clay	674	704

Hard sandstone, dark pebbles	704	739
Soft light-blue sandstone	739	754
Hard sandstone	754	760
Soft blue sandy clay	760	811
Soft blue clay with coarse sand	811	835
Soft blue clay	835	915
Dark open sandstone	915	935
Dark brown sticky clay (asphaltic oil)	935	975
Soft white limestone, Austin chalk	975	1000

The Haass well is located in the area surficially occupied by the Squirrelcreek formation of the Eocene-Midway. The location is immediately south of the Cretaceous-Eocene contact. Though no samples of this well were obtained, it is quite evident from the log that the following formations were penetrated, at the depths below the surface which are indicated:

	Feet
Squirrelcreek formation, Eocene-Midway	0–15
Elstone formation, Eocene-Midway	15–57
Escondido formation, uppermost Cretaceous in Medina County	57–811
Anacacho formation, at its base probably including some to to 20 feet of the Upson formation	811–975
Austin formation	975–1000

In the Haass well there is now obtained a few gallons of oil per day from the Escondido at 350 feet. The main oil horizon, the Anacacho limestone, which produced two barrels a day from between 700 and 800 feet is completely shut off.

Johnson Farm Oil Test

Log of Hendon Oil Company's Johnson Farm No. 1 well located on the Virgil Johnson tract, 14 miles southwest of D'Hanis, Medina County.

	Depth in feet below surface	
Gravel	0	12
Blue clay	12	190
Rock	190	191
Gumbo and asphalt	191	570
Oil sand shale	570	670
White shale	670	675
Rock	675	676
White	676	780
Lime	780	860

Sand, salt water, 100 barrels a day	860	865
Lime	865	880
Blue shale	880	885
Lime	885	898
Blue shale	898	902
Lime	902	908
Sandy shale	908	960
Lime	960	962
Blue shale	962	980
Lime	1025	1062
Soapstone	1062	1065
Lime	1065	1100
Gray shale	1100	1220
Gray brown shale	1220	1240
Lignite	1240	1241
Gray shale	1241	1265
Brown shale	1265	1283
White shale	1283	1292
Gray shale	1292	1275
Flint rock	1375	1394
Brown shale	1394	1460
White limestone, gas	1460	1545
Gumbo	1545	1615
Lime	1615	1617
Lime, honey-combed; strong flow of fresh water	1617	1715
Lime	1715	2000

The log of the Johnson test No. 1 in southwestern Medina County indicates a rapid thickening to the west of the Anacacho and Escondido formations of the Upper Cretaceous. The aggregate thickness of these two formations in eastern Medina County is approximately 900 feet, while in western Medina County they total about 1200 feet. The increase in the thickness of these two formations of the Upper Cretaceous to the west is naturally expected to be rapid, considering the extreme thickness of some 400 feet which the Anacacho measures at the west side of the Anacacho Mountains in Kinney County, and the rapid increase in the thickness of the Escondido to the west of Medina County.

The log of the Johnson test No. 1 is interpreted as follows:

	Feet
Surface gravels, Recent	0–12
Escondido formation, Upper Cretaceous	12–1025
Anacacho formation (probably including some Upson clay), Upper Cretaceous	1025–1220
Eagleford formation, Upper Cretaceous	1220–1241
Buda formation, Comanchean-Cretaceous	1241–1265

Del Rio formation (evidently not the entire thickness of the formation), Comanchean-Cretaceous. 1265–1283
Georgetown-Edwards formation, Comanchean-Cretaceous. .1283–2000

Medfrio Oil Corporation Test

Log of Medfrio Oil Corporation No. 1 well, eight miles southwest from Yancey, Medina County.

	Depth in feet below surface	
Sand.	0	2
Clay and rock	2	2
Gray adobe	5	12
Red adobe	30	38
Blue mud	38	68
Blue rock, hard (water)	81	84
Lignite.	84	120
Gray sand.	120	200
Sand rock (water)	220	245
Gray sand rock	270	285
Gumbo.	285	368
Gray rock.	368	372
Gumbo.	372	392
Asphalt.	395	412
Blue rock.	413	438
Gumbo.	428	445
Blue rock.	445	447
Gumbo.	456	460
Flint rock.	460	463
Gumbo.	463	480
Blue clay.	480	050
Blue sandstone.	505	507
Blue clay.	507	555
Blue clay and flint rock.	555	570
Blue mud.	570	588
Blue rock.	588	590
Blue mud.	590	629
Lime and rock with brown flint.	629	678
Blue mud.	678	686
Lime and brown flint	686	697
Blue mud.	697	706
Lime and brown flint	706	713
Blue mud	713	717
Lime and brown flint	717	728
Blue mud.	728	749
Lime and brown flint	749	754

Gumbo, hard.	754	757
Gumbo.	757	769
Gumbo, hard.	769	772
Lime, hard.	772	775
Gumbo.	775	794
Blue rock.	794	795
Gumbo.	795	814
Blue rock.	814	816
Gumbo.	816	818
Blue rock, hard.	818	820
Sand and salt, sulphur	820	822
Blue rock (60 bbls. day hot salt water)	822	823
Gray Sand.	823	826
Blue rock.	826	829
Gray Sand (oil)	824	833
Gumbo.	823	837
Rock.	837	840
Gumbo.	840	870
Lime rock.	870	877
Gumbo.	877	880
Rock.	880	884
Gumbo.	884	900
White shale, gas	900	912
Gumbo.	912	931
Lime rock.	931	934
Gumbo.	934	951
Lime rock.	951	953
Gumbo.	953	974
Lime rock.	974	976
Gumbo.	976	992
Lime rock.	992	996
Gumbo.	996	1002
Lime rock.	1002	1004
Gray shale.	1004	1012
Lime rock.	1012	1015
Gray shale.	1015	1020
Lime rock.	1020	1033
Shale.	1033	1061
Rock.	1061	1064
Shale.	1064	1092
Rock.	1092	1095
Shale.	1095	1119
Rock.	1119	1128
Shale.	1128	1153
Rock.	1153	1154

Shale.	1154	1165
Rock.	1165	1168
Shale.	1168	1214
Rock.	1214	1215
Shale.	1215	1243
Rock.	1243	1244
Shale.	1244	1270
Rock.	1270	1271
Shale, oil and gas show	1271	1278
Rock.	1278	1281
Brown shale, oil and gas show	1281	1321
Brown hard shale, oil and gas	1321	1371
Brown hard shale, oil and gas	1371	1345
Gray sandstone.	1345	1350
Black sandy clay and show of oil	1350	1407
White soft lime	1404	1407
Dark sandy shale, oil show	1407	1436
Light sandy shale, oil show	1436	1482
Gray sand rock	1482	1492
Dark shale, oil show	1492	1542
Gray sandstone.	1542	1546
Dark gray shale, oil show	1546	1601
Dark sand rock.	1601	1609
Soapstone.	1609	1615
Dark gray shale, show	1615	1622
Light gray shale.	1622	1638
Dark gray shale.	1638	1642
Light gray shale.	1642	1669
Dark gray shale.	1669	1676
Light gray shale, oil and gas show	1676	1720
Lime, hard.	1720	1722
Brown sandstone.	1722	1727
Light gray shale.	1727	1759
Lime rock, gas.	1759	1788
Gray sand.	1788	1791
Light gray shale.	1791	1796
Dark shale, oil.	1796	1824

The log of the Medfrio test, located eight miles southwest from Yancey is probably the most difficult to interpret of any of the logs in Medina County. Judging from the descriptions of the formations given in the log and checking these figures against the more obvious data from the Johnson test, the position and thickness of the formations are considered to be as follows:

Surface sand, Recent	0–2
Wilcox, Eocene	2–629
Midway, Eocene	629–759
Escondido and Anacacho formations, Upper Cretaceous	759–1824

The record of this test is incomplete as drilling is still being continued. Below the top of the Escondido there are no definite horizons which may be identified with certainty. Since this is the situation the strata between 759 and 1824 feet (which was the depth at the time the field work for this report was done) are collectively assigned to the Anacacho and Escondido. More information regarding the strata which have been penetrated below 1824 feet will very probably afford the definite information as to the depth at which the Austin chalk is encountered. With such a definite horizon established it will be much easier and more accurate to determine the position of and thickness of the Anacacho and Escondido formations.

The recording of brown flint from the Midway horizon is not understood, for no flint was found in any surface exposure or other subsurface exploration penetrating the Midway. The Midway, however, is full of brown calcite concretions, and possibly the references in the driller's log to brown flint should read "brown calcite."

Later samples examined show the test to be in the Eagleford at 2370 feet. From at least 2370 to 2385 feet are Eagleford. Probably 15 feet of Eagleford above 2370 feet. Eagleford-Buda contact between 2385 feet and 2390 feet. Last samples, at 2390 feet still in the Buda. Full thickness of Eagleford and Buda not represented by samples examined.

McClure Well Near Dunlay

Log of Thomas S. McClure well No. 1, three miles southeast of Dunlay Station on the Southern Pacific Railroad, Medina County. Driller, . M. Burkett. Log furnished by Thos. S. McClure, 142 Goliad Street, San Antonio, Texas.

	Depth in feet below surface	
Flint gravel and adobe clay	0	40
Clay, yellow, soft	40	64
Clay, yellow, hard and soft; rock	64	74
Mud, blue, soft	74	239
Shale, blue, soft	239	245
Mud, blue soft	245	260
Shale, blue, soft, oil showing (two barrels)	260	271
Clay, light blue, soft	271	309
Shelly rock, blue, harder, oil showing (one and a one-third barrels)	309	311

Clay, dark blue, soft	311	335
Shale, dark blue, soft	335	337
Clay, blue, soft	337	372
Rock, gray brown, hard	372	373
Clay, blue, hard	373	413
Rock, light gray, hard	413	414
Clay, blue, soft	414	435
Rock, blue gray, hard	435	438
Shale, part sandstone, gray, hard, little oil (two barrels?), 40 gravity	438	450
Mud (clay), gray, soft	450	490
Mud, gray, soft	490	520
Clay, gray, soft	520	630
Half-inch streaks of sand in clay, gray, soft, oil showing	630	634
Clay, gray, soft with harder streaks, all caved badly (two barrels?)	634	684
Clay, gray, soft; oil showing, last foot	684	694
Chalk or lime, light gray, hard; top of Austin at 694 feet	694	704
Chalk or limestone, light gray, hard	704	772
Chalk, light blue, softer	772	870
Rock, cream color, hard	870	882
Chalk, cream-colored, quite hard	882	998
Slate, black, hard	998	999
Limestone or chalk, creamy, hard	999	1013
Shale, dark, hard	1013	1017
Limestone, gray, hard	1017	1020
Shale, gray, soft	1020	1026
Chalk, cream, hard; bottom of Austin 418 feet (Eagleford 38 feet)	1026	11[illegible]
Shale, very dark medium, very bituminous	1112	1150
Lime, white, hard, Buda lime, 69 feet Del Rio clay	1150	1219
Clay, light blue, soft, stocky-caves	1219	1233

No water was found in any part of this hole.

United States Geological Survey Log and Description of Samples, and Interpretation

	Depth in feet below surface	
Clay, drab, sandy, limestone concretion (?)	20	40
Same as above	40	60
Sandy clay, light gray, very fine-grained, highly calcareous	60	80
Same as above	80	100
Clay, gray calcareous	100	120

Clay, bluish gray, calcareous, and some fine sandy clay	120	140
Clay, bluish gray, calcareous, sandy............	140	160
Clay, bluish gray, calceraus	160	180
Clay, gray, calcareous, sandy	180	200
Clay, gray, plastic, calcareous	200	220
Clay, gray, plastic, fragments of shells............	220	240
Clay, gray, calcareous, somewhat sandy............	240	260
Clay, gray, sandy, calcareous	260	280
Clay, sandy, and fine argillaceous sand, gray, calcareous.	280	300
Clay, gray, hard, massive, calcareous	300	320
Clay, hard, gray, calcareous, and very fine argillaceous sand.	320	340
Clay, gray, hard, massive, calcareous	340	360
Same as above	360	400
Same as above	400	420
Clay, greenish gray, hard, massive, calcareous	420	435
Chalk, and glauconitic clay, light gray, many shell fragments (*Crenella serica* Conrad) probably Navarro.	435	438
Sand, brown, fine-grained, and glauconitic, gray, chalky limestone. Sand has petroleum odor and yields much oil when treated with ether......	438	450
Clay, fine argillaceous sand, and hard, gray, glauconitic limestone.	450	470
Clay and fine argillaceous sand, gray, calcareous....	470	490
Sand, fine, greenish gray, glauconitic(?) argillaceous	490	510
Sandy clay, greenish gray.	510	530
Sandy clay, fine-grained, greenish gray, glauconitic	530	550
Sandy clay, fine-grained, greenish gray, and massive gray clay.	550	570
Clay, hard, massive, gray, and sandy clay..........	570	590
Clay, fine-grained, glauconitic, calcareous, sandy....	590	630
Clay, dark gray, finely sandy, slightly calcareous....	630	640
Clay, light gray, finely sandy, calcareous..........	640	660
Clay, gray, finely sandy, calcareous, with several small chunks of gray highly calcareous sandstone	660	680
Chalk, light gray, mixed with gray clay, both highly calcareous; one chunk of fine brownish gray sandstone.	680	700
A. Unwashed sample: Chalk, light gray, with chunks of light gray, calcareous clay.		
B. Washed sample: Mixture of sand, small fragments of chalk, chunks of highly calcareous, glauconitic sandstone, and chunks of gray, highly calcareous, sandy, glauconitic clay	700	720

Chiefly fragments of hard sandy gray limestone....	720	740
Chalk, light gray (unwashed)	740	772
Chalk, light gray, argillaceous	772	870
Chiefly small fragments of hard limestone..........	870	884
Chiefly fragments of limestone; a few fragments of calcareous shale and broken shells............	884	900
Fragments of chalk, calcareous shale and limestone; some pyrite.	900	924
Fragments of chalk and calcereous shale; some pyrite and shell fragments	924	940
Chiefly chalk with some calcareous shale..........	940	960
Chalk, white.	960	998
Fragments of calcareous shale and some limestone and chalk.	998	999
Fragments of calcareous shale, chalk and limestone	999	1017
Chiefly light gray chalk with some fragments of dark gray shaly chalk	1017	1032
Chalk, light gray	1032	1045
Chalk, light gray	1045	1057
Chalk, light gray with some fragments of darker gray calcareous shale.	1057	1069
Chalk, white.	1069	1080
Chiefly chalk, light gray	1080	1100
Chalk, white.	1100	1110
Dark gray somewhat calcareous shale, emitting strong odor of petroleum; no test made for oil........	1110	1130
Same as the preceding..........................	1130	1140
Same as the preceding, but includes a few fragments of hard creamy limestone, probably derived from the top of the Buda limestone................	1140	1150

The first sample (720-740 feet) may represent the Anacacho formation. The others (740-884) have the physical appearance of Austin chalk, and with reasonable certainty belong to that formation.

The writer's interpretation of the McClure log practically agrees with the other interpretation, and is as follows:

	Feet
Recent.	0–40
Escondido, Upper Cretaceous	40–630
Anacacho, possibly containing a few feet of the Upson clay in the base of the formation; Upper Cretaceous.......	630–740
Austin, Upper Cretaceous	740–1110
Eagleford, possibly reaching top of Buda at the bottom of the hole; Upper Cretaceous, possibly reaching Comanchean-Cretaceous.	1110–1150

The termination of the upper glauconitic horizon occupied by calcareous sandy clay, and this horizon being underlain by dark gray, sandy, non-glauconitic clay practically establishes the contact of the basal Escondido with the underlying Anacacho formation at 630 feet. The contacts of the Anacacho with the Austin chalk and the Austin chalk, in turn, with the Eagleford, are quite readily indicated by the nature of the material.

The Kimball Test

Located two miles south of Devine, Medina County. A complete log of this well as yet has not been obtained. However, one sample from this well, at 873 feet is evidently from the upper part of the Midway. The Carrizo formation is on the surface at the location of the test.

NOTE

Dr. L. W. Stephenson has kindly submitted to the Bureau notes on Medina County, in which he records exposures of the Eagleford on Hondo River at a locality approximating five miles north of Hondo. This observation has been verified by Dr. Sellards, who lately visited the locality. The Austin formation is reported by Stephenson also at a locality approximately four miles north of Hondo, and he has found strata which he refers to the Anacacho in an area northeast from Castroville on the southwestward extension of the Culebra Uplift in Bexar County. These notes were received too late to be shown on the map.

J. A. UDDEN.

INDEX

ERA	SYSTEM	GROUP OF SERIES	FORMATION	SYMBOL	COLUMNAR SECTION	THICKNESS	CHARACTER OF FORMATIONS	CHARACTER OF TOPOGRAPHY AND SOIL
RECENT PLEISTOCENE			LEONA	PL		0 - 100	SILT WITH FLINT AND LIMESTONE GRAVEL.	BLACK TO YELLOW TERRACE DEPOSITS. SILT MIXED WITH GRAVEL.
PLIOCENE			UVALDE	PLU		6-50	FLINT FROM EDWARDS LIMESTONE. OFTEN CEMENTED WITH CALICHE.	THIN FLINT MANTLE. GENERALLY UNCONSOLIDATED. SOMETIMES STAINED RED.
CENOZOIC	EOCENE	CLAI-BORNE	CARRIZO	ECC		100+	COARSE QUARTZ SAND. BASAL PART CROSSBEDDED AND STAINED RED WITH IRON FROM CLAY IRONSTONE INCLUSIONS. REST OF FORMATION GRAY.	LOW GRAY SAND HILLS OR DEEP GRAY SAND. BASAL PART WEATHERS TO A DEEP RED SANDY SOIL.
CENOZOIC	EOCENE	WILCOX	SECO	EWS		100+	VARIEGATED ARENACEOUS SHALES, PREDOMINANTLY DEEP RED. FEW LENSES OF BROWN-RED TO DEEP RED ARENACEOUS LIMESTONES.	DEEP RED SANDY SOIL WITH THIN PARTICLES OF VARIEGATED SHALE.
CENOZOIC	EOCENE	WILCOX	BUTTSGIN	EWB		500+	YELLOW, BROWN, BROWN-RED ARENACEOUS SHALES WITH ARENACEOUS LIMESTONE AND CALCAREOUS SANDSTONE LENSES. NO REGULARITY OF OCCURRENCE OF THE LENSES. BASAL PART OF THE FORMATION CONTAINS MORE CALCAREOUS MATTER IS HARDER, AND FORMS A RANGE OF HILLS. UPPER PART WEATHERS TO A MORE SANDY SOIL.	BASAL PART OF FORMATION CONTAINS MORE CALCAREOUS MATTER AND WEATHERS DARKER. FORMS A RIDGE OF HILLS ACROSS THE COUNTY. HILLS GENERALLY COVERED WITH UVALDE FLINT. SHALES WEATHER RED. UPPER PART OF FORMATION AFFORDS DEEPER RED SANDY SOIL.
CENOZOIC	EOCENE	MIDWAY	SQUIRREL CREEK	EMS		75-100	IMPURE GRAY-YELLOW FOSSILIFEROUS LIMESTONE WITH BROWN CALCITE CRYSTALS AND CONCRETIONS. CHARACTERISTIC FOSSILS: TURRITELLA MORTONI, OSTREA CRENULIMARGINATA, CUCULLAEA SAFFORDI, LEDA SP., VENERICARDIA ALTICOSTATA.	FORMS THE FRONT OF A SMALL NORTH TO NORTHWEST FACING ESCARPMENT. QUITE RESISTANT. WEATHERS TO DARK CALCAREOUS SOIL.
CENOZOIC	EOCENE	MIDWAY	ELSTONE	EME		30	IMPURE YELLOW, GLAUCONITIC LIMESTONE, ARGILLACEOUS AND ARENACEOUS. POORLY FOSSILIFEROUS. TURRITELLA MORTONI, CUCULLAEA SP., LEDA SP.	UNIFORMLY SOFT. WEATHERS RAPIDLY AND UNDERCUTS OVERLYING FORMATION.
MESOZOIC	CRETACEOUS	UPPER CRETACEOUS	ESCONDIDO	KES		650 - 700	MEDIUM FINE TO FINE GRAINED SANDY LIMESTONES AND ARENACEOUS SHALES INTERBEDDED. MORE MARLY TOWARD BASE OF FORMATION. FEW LIMESTONES IN BASE. CALCAREOUS AND MUCH HARDER BROWN-YELLOW LIMESTONE LEDGES TOWARD TOP OF FORMATION. FOSSILIFEROUS THROUGHOUT. DISTINCT FOSSIL HORIZONS. GRYPHEA VESICULARIS HORIZON NEAR BASE. EXOGYRA PONDEROSA HORIZON IN LOWER PART. SPHENODISCUS PLEURISEPTA AND OSTREA CORTEX HORIZONS NEAR TOP. OTHER FOSSILS ARE: EXOGYRA COSTATA, TURRILITES SP., ANANCHYTES TEXANA, PACHYDISCUS SP., INOCERAMUS SP., SHARKS TEETH.	BASAL PART MORE ARENACEOUS AND ARGILLACEOUS. WEATHERS RAPIDLY TO A YELLOW OR BLACK PLAIN. SOIL IS A DARK BROWN TO BLACK OR YELLOW CLAY LOAM WITH LIMESTONE FRAGMENTS. THE UPPER PART IS MORE CALCAREOUS AND MORE RESISTANT. THIS PART FORMS A RANGE OF HILLS IN EASTERN AND WESTERN PARTS OF THE COUNTY. HILLS ARE GENERALLY CAPPED WITH UVALDE FLINT. THE SOIL OF THE UPPER PART OF THE FORMATION IS MORE CALCAREOUS ANDLIGHTER IN COLOR.
MESOZOIC	CRETACEOUS	UPPER CRETACEOUS	ANACACHO	KAN		200+	COARSE ORGANIC FRAGMENTAL LIMESTONE. BEACH DEPOSIT. GENERALLY ASPHALTIC. LOCAL ASPHALT SEEPS. MORE CALCAREOUS IN WESTERN PART OF COUNTY. CALCAREOUS MATTER CHIEFLY FROM COMMINUTED TESTS OF ECHINOIDS. FOSSILS ARE: ECHINODERMS, BACULITES. MORE FOSSILIFEROUS IN EASTERN PART OF COUNTY.	EASTERN AND MORE ARENACEOUS OR ARGILLACEOUS PART WEATHERS TO A DEEP BLACK CLAY LOAM PLAIN. THE WESTERN PART IS HARDER, MORE CALCAREOUS, AND FORMS A RIDGE OF HILLS.
MESOZOIC	CRETACEOUS	UPPER CRETACEOUS	UPSON	KU		20+	YELLOW CLAY. NOT EXPOSED AT SURFACE IN MEDINA COUNTY.	NO SURFACE EXPOSURE IN MEDINA COUNTY
MESOZOIC	CRETACEOUS	UPPER CRETACEOUS	AUSTIN	KA		350+ 400	WHITE AND YELLOW CHALKY LIMESTONES, WITH MARL BEDS, SOME PARTS HIGHLY GLAUCONITIC. MANY CYLINDRICAL IRON PYRITE CONCRETIONS. VERY FOSSILIFEROUS: GRYPHEA AUCELLA, INOCERAMUS SP., SCHLOENBACHIA SP., EXOGYRA PONDEROSA, PYRINA SPECIES.	THE CHALK WEATHERS TO A DEEP BLACK CLAY LOAM IN THE INTERSTREAM AREAS. ALONG THE STREAMS IT STANDS AS WHITE BLUFFS. ON FRESHLY ESPOSED SURFACES IT IS YELLOW TO WHITE BUT SOON WEATHERS DARKER.
MESOZOIC	CRETACEOUS	UPPER CRETACEOUS	EAGLE-FORD	KEF		30	GRAY MARL AND CALCAREOUS OR ARENACEOUS FLAGS. SHARK TEETH.	GRAY MARLS AND SHALES. TOPOGRAPHY THE SAME AS THE AUSTIN FORMATION.
MESOZOIC	CRETACEOUS	COMANCHEAN CRETACEOUS	BUDA	KB		60	HARD YELLOW-BROWN LIMESTONE, SMOOTH, SPLINTERY FRACTURE. CALCITE SEAMS DISTINCTLY NODULAR. SOME PINK BLOTCHES.	WEATHERS TO A HARD WHITE RIDGE. SOMETIMES CAPS DEL RIO OUTLIERS.
MESOZOIC	CRETACEOUS	COMANCHEAN CRETACEOUS	DEL RIO	KDR		60	BLUE CLAY AND FLAGS. WEATHERS YELLOW. LIMONITE PARTICLES. EX. ARIETINA	NARROW VALLEY. SURFACE YELLOW OR BLACK AND COVERED WITH LIMONITE.
MESOZOIC	CRETACEOUS	COMANCHEAN CRETACEOUS	GEORGE-TOWN	KG		40+	HARD BLUE-GRAY LIMESTONE. PRACTICALLY NO FLINT. CHIEF FOSSIL IS KINGENA WACOENSIS. RUDISTIDS.	SOIL AND TOPOGRAPHY CANNOT BE DISTINGUISHED FROM EDWARDS AREA. GENERALLY LESS FLINT THAN ON EDWARDS AREA.
MESOZOIC	CRETACEOUS	COMANCHEAN CRETACEOUS	EDWARDS	KE		450+	HARD, BLUE-GRAY, MASSIVE, FLINT-BEARING LIMESTONE. POORLY FOSSILIFEROUS VERY FEW MARLY LEDGES. BEDDING AND JOINTING INDISTINCT. CHARACTERISTIC FOSSILS: MONOPLEURA, REQUIENIA, ITHYSARCOLITES, MASSIVE BLUFFS. FREQUENTLY CAVERNOUS.	VERY ROUGH AND BROKEN TOPOGRAPHY. STEEP BLUFFS OR DEEP CANYONS. HILLS GENERALLY BOUNDED BY STEEP SCARPS. WEATHERS CAVERNOUS IN PLACES. SURFACE COVERED BY BOULDERS AND PEBBLES OF FLINT. SOIL THIN AND CALCAREOUS. SUPPORTS SCANTY VEGETATION.
MESOZOIC	CRETACEOUS	COMANCHEAN CRETACEOUS	COMANCHE PEAK	KCP		30	NODULAR, ARGILLACEOUS, IMPURE LIMESTONE. FEW EXOGYRA TEXANA.	NOT SUFFICIENT SURFACE EXPOSURES TO AFFECT TOPOGRAPHY.
MESOZOIC	CRETACEOUS	COMANCHEAN CRETACEOUS	WALNUT	KW		20	SOFT, YELLOW, CALCAREOUS CLAY, FULL OF EXOGYRA TEXANA.	SMALL SURFACE EXPOSURES. NO EFFECT ON TOPOGRAPHY
MESOZOIC	CRETACEOUS	COMANCHEAN CRETACEOUS	GLENROSE	KGR		800+	YELLOW, ARENACEOUS, AND ARGILLACEOUS LIMESTONE, THIN-BEDDED, ALTERNATING MORE CALCAREOUS AND ARGILLACEOUS LEDGES. NO FLINT. VERY FOSSILIFEROUS, WITH CARDIUM MEDIALE, HOMOMYA, TYLOSTOMA, TYLOSTOMA PEDERNALIS, PECTEN, TURRITELLA, EXOGYRA.	VARIED TOPOGRAPHY OF SMOOTH, CONICAL, GENTLE SLOPING HILLS. NO ABRUPT SCARPS. HILLS HAVE A BANDED APPEARANCE DUE TO ALTERNATING HARD AND SOFT LEDGES. NO FLINT IN THE FORMATION OR ON THE SURFACE. GOOD SOIL MORE YELLOW IN COLOR THAN THE EDWARDS AREA. SUPPORTS CEDAR, SPANISH OAK, AND, IN THE VALLEYS. CONSIDERABLE GRASS AND MESQUITE TREES. MANY FLOWING SPRINGS IN THE AREA.

Plate 1

Generalized columnar section of the sedimentary rocks of Medina County.

Scale, 1 inch=640 feet

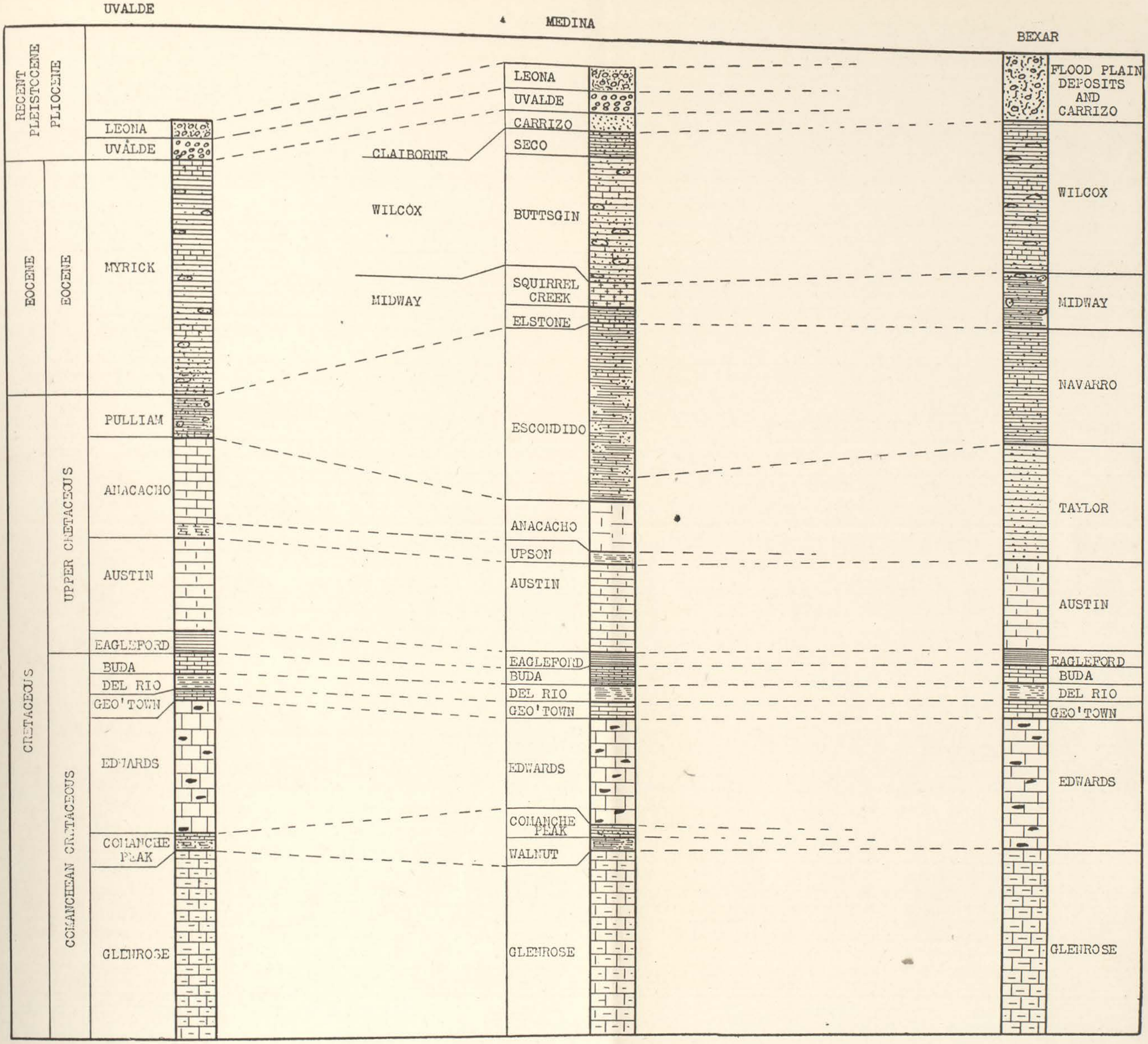

Plate 2

Correlation of the strata exposed in Uvalde, Medina, and Bexar Counties.

Scale, 1 inch = 640 feet

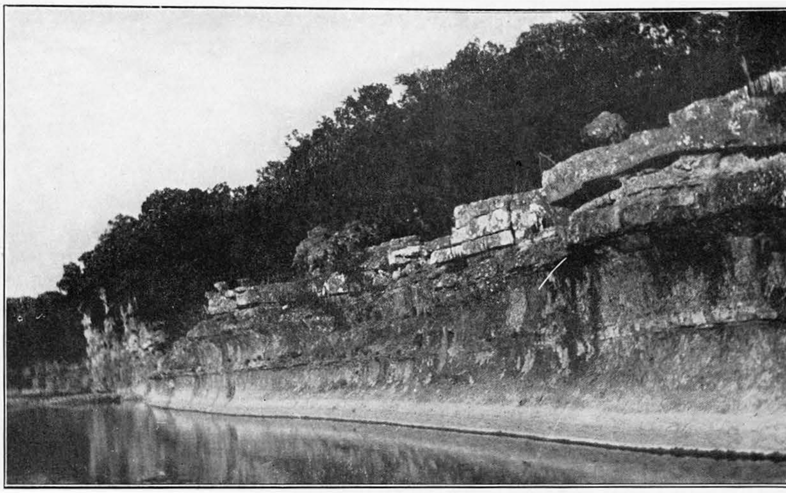

Plate 3 (A)

Edwards limestone on the Hondo River, 18 miles northwest of Hondo. At this locality the river flows west in the main Balcones Fault. The Edwards limestone is the south side of the fault. Looking south.

Plate 3 (B)

Igneous dike of basalt in the Glenrose limestone area, looking southeast. The dike is one-quarter mile long and about 15 feet wide. It is located on Cow Creek, one mile above the junction of this creek with the Middle Verde Creek.

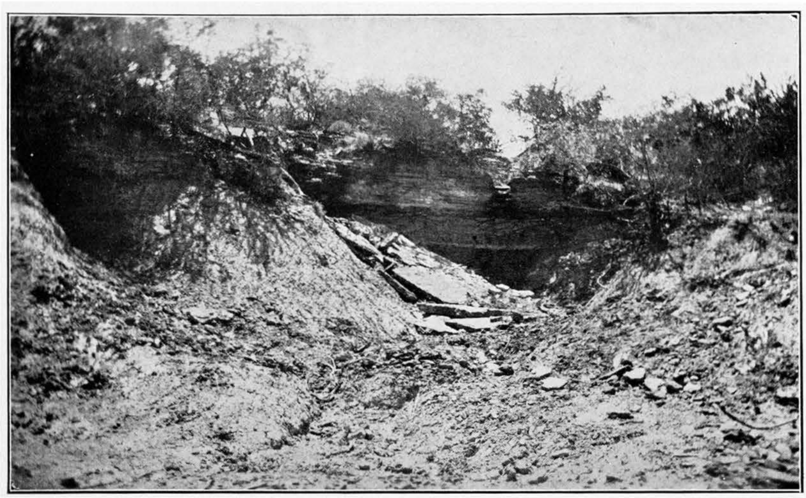

Plate 4 (A)

Seco formation of the Wilcox on the Ward Ranch road, five miles south of west from Yancey. Looking east.

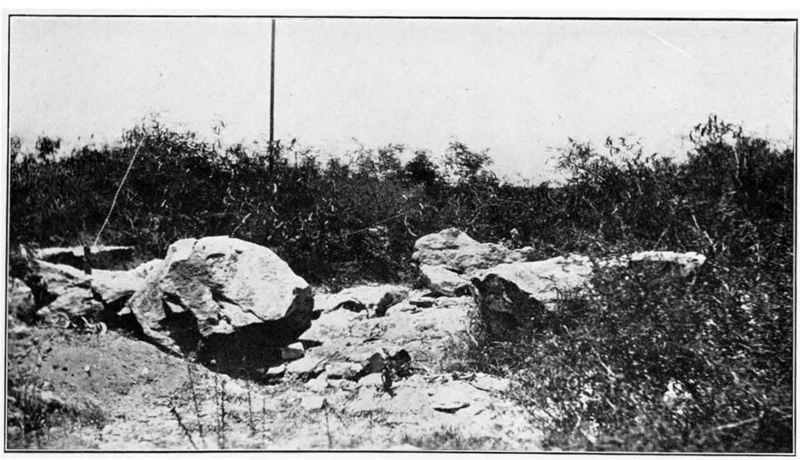

Plate 4 (B)

Carrizo sandstone outlier capping a Wilcox hill three miles northwest of Devine. Looking south.

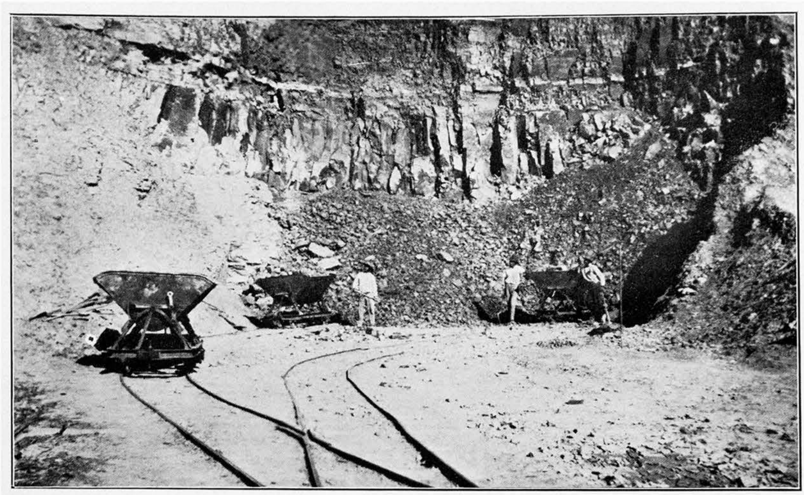

Plate 5 (A)

Clay pit of the D'Hanis Brick and Tile Company on the Seco Creek, one mile north of west from D'Hanis. The pit is 100 feet above the base of the Escondido. Looking northwest.

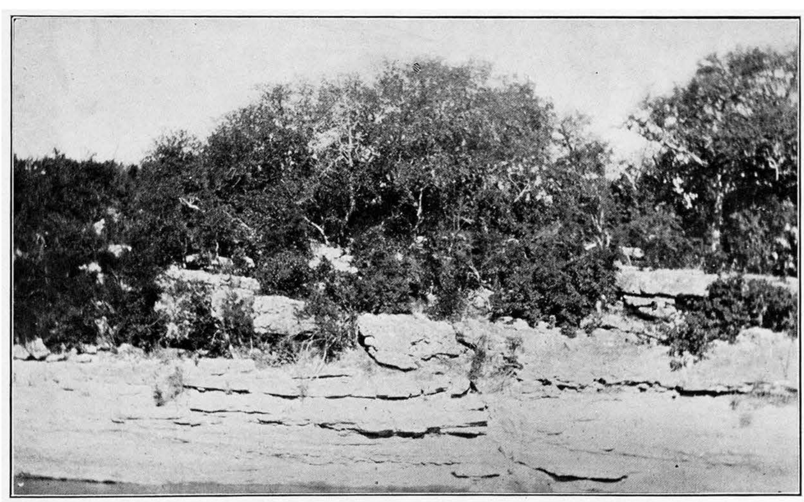

Plate 5 (B)

Anacacho limestone, west bank of Seco Creek, five and one-half miles north of D'Hanis, showing north dip into fault. Looking west.

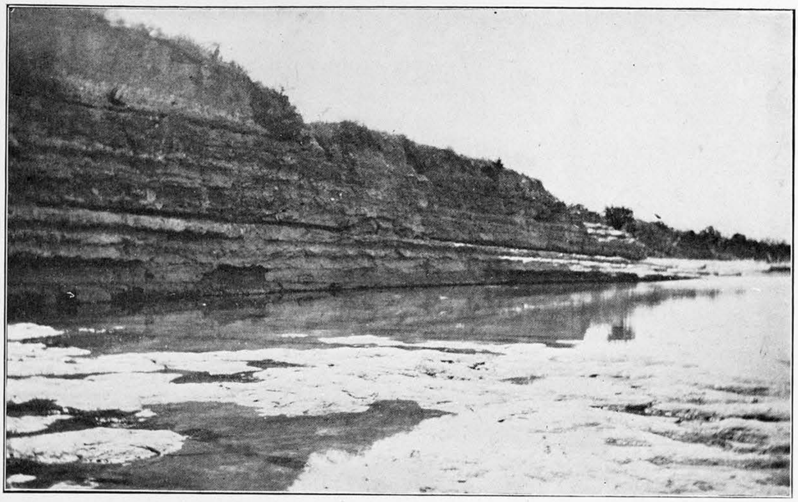

Plate 6 (A)

Anacacho and Escondido formations at King's water-hole, on the Hondo River two and one-half miles north of Hondo. Anacacho limestone in the river bed. Escondido in the bluff on the east bank of the river. Looking northeast.

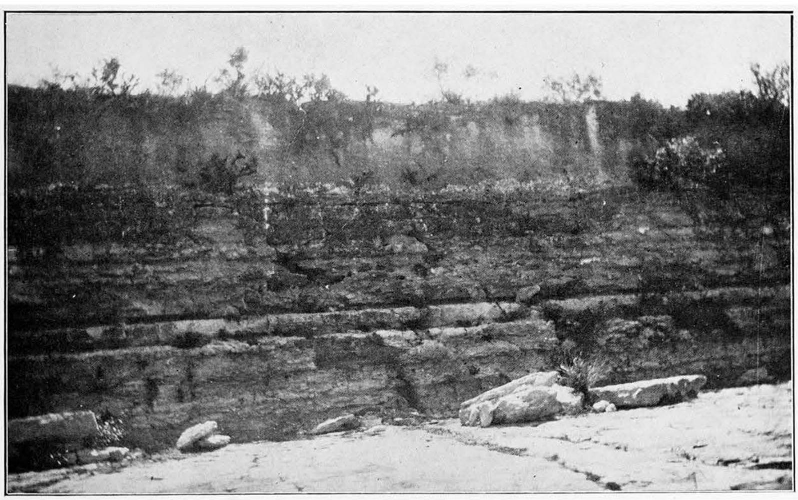

Plate 6 (B)

Anacacho-Escondido contact at King's water-hole on the Hondo River. The Escondido occupies the east bank of the river. The contact is at the foot of the river bank by the boulders. Looking northeast.

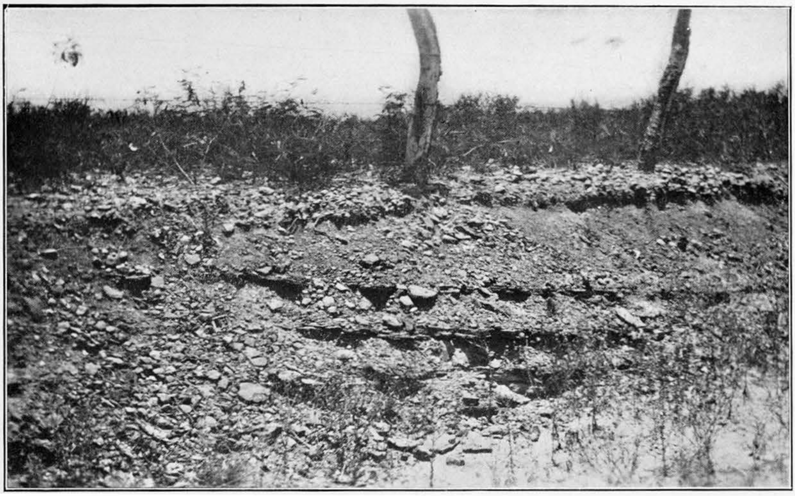

Plate 7 (A)

West dip in the Seco formation of the Wilcox on the south side of the Devine structure, three miles northwest of Devine. Looking south.

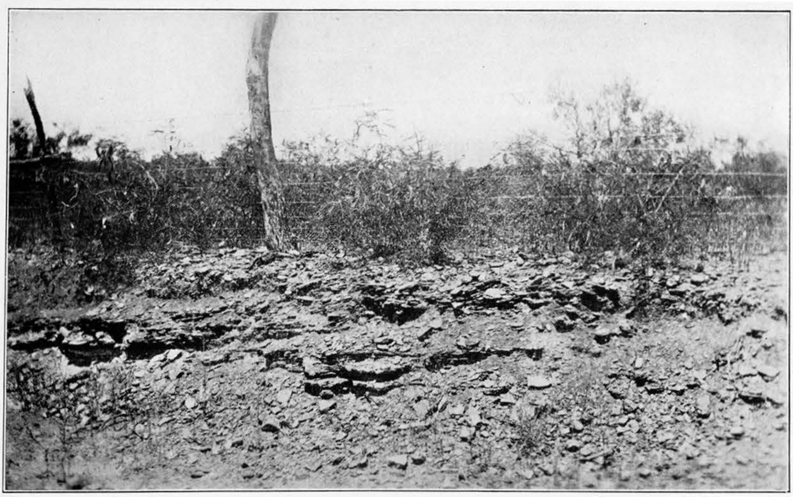

Plate 7 (B)

West dip in the Seco shales near the above locality. Looking north.

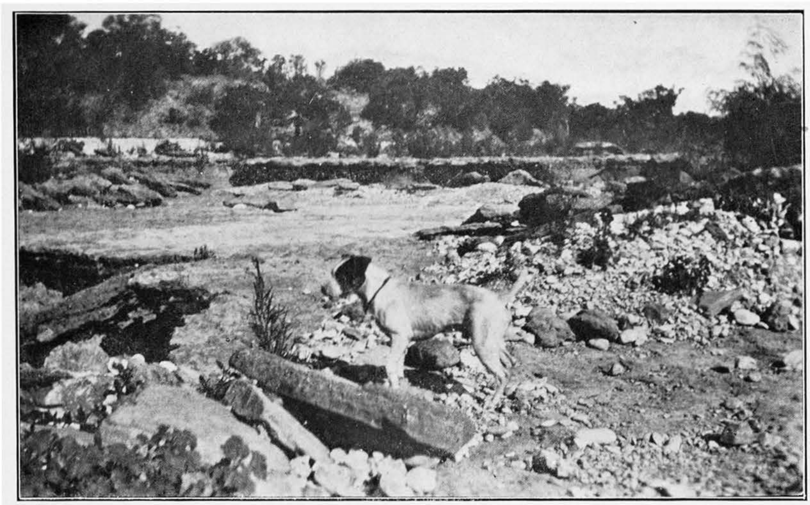

Plate 8 (A)

Sphenodiscus pleurisepta horizon of the Upper Escondido at Rock Crossing on the Hondo River.

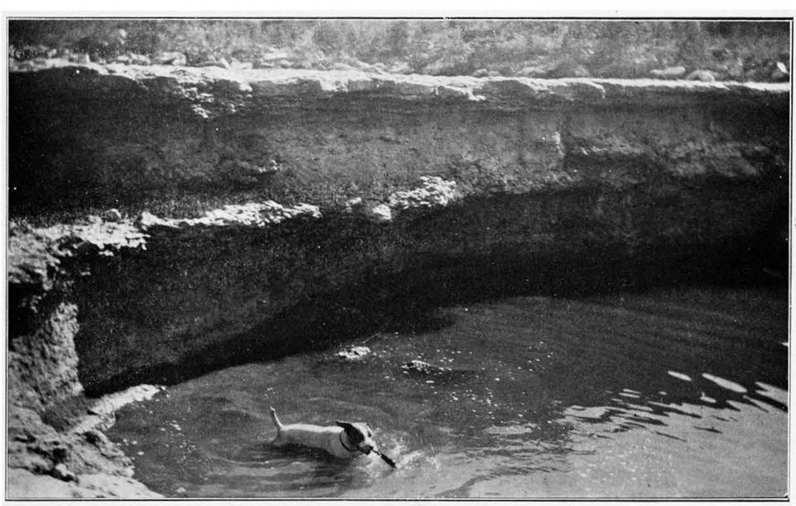

Plate 8 (B)

Alternating more and less indurated ledges of the Escondido, at Rock Crossing, on the Hondo River.

UNIVERSITY OF TEXAS
BUREAU OF ECONOMIC GEOLOGY AND TECHNOLOGY
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BULLETIN 1860, PLATE 9